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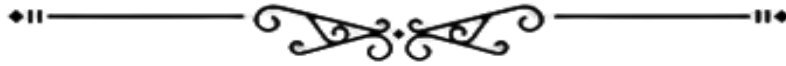
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## 3rd INTERNATIONAL GRADUATE CONFERENCE OF BUILT ENVIRONMENT & SURVEYING

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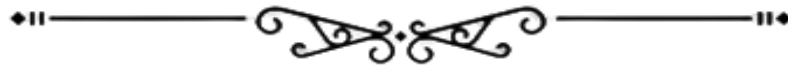
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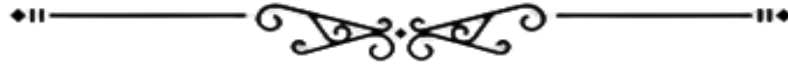
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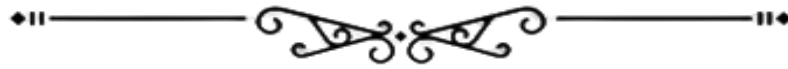Mr. Iqmal Nor Bin Mohd Noh

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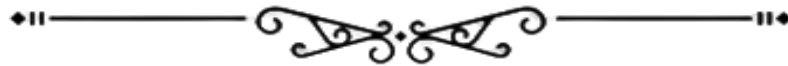
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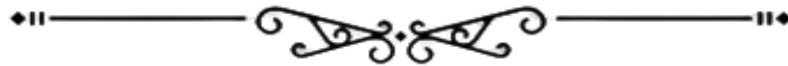Sr Dr. Azizah Binti Ismail

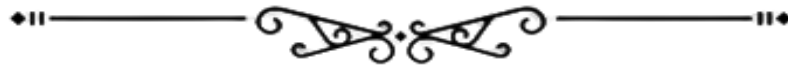Dr. Salfarina Binti Samsudin

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# REAL ESTATE

# APPLICATION OF COMPUTER ASSISTED MASS APPRAISAL (CAMA) IN REAL ESTATE PROFESSION IN NIGERIA: A REVIEW OF VALUATION MODERN TECHNIQUES

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## ABSTRACT

The study seeks to review the application of computer assisted mass appraisal in Nigeria real estate profession as valuation modern techniques with the emphasis on review of Multiple Regression Analysis, Artificial Neural Networks, Random Forest as among the valuation modern techniques as most of the valuations are carrying out using traditional methods of valuation. In Nigeria, most of the real estate has traditionally been valued using traditional methods such as comparison, cost, investment, profit, and residual methods. Using a manual valuation method may sometimes contribute or produce a poor-quality result due to the problem of huge numbers of properties and the massive amount of data involved. Besides that, is very tedious, time-consuming, and high cost. To restore confidence in real estate financial assets and securities, property valuation system accuracy can play a key role in the financial mechanisms and contribute more comprehensive in property price process formation making in the housing and real estate market. As a result, new approaches and techniques for real estate mass appraisal have been introduced. The significance of prediction accuracy in computer-assisted mass appraisal (CAMA) has long been debated, particularly in the areas of model explain ability and assessed value defensibility. In the last two decades, the development of alternative automated valuation methods to support price estimation has grown in popularity. There is need of introducing these modern techniques in Nigerian real estate for valuation purposes by avoiding time consuming, high cost and producing a poor-quality result due to problem of huge numbers of properties and massive amount of data involved because of using traditional methods of valuation.

Keywords: *Mass Appraisal, MRA, ANN, RF, CAMA, and Property Value*

## 1.0 INTRODUCTION

In the process of "knowing the value" is like that which exists in every other commodities market. However, there is widespread understanding that property market value is difficult to pin down (McParland et al., 2000). Furthermore, unlimited on property values, the lags presence in acknowledging a property worth causes, as well as a faulty assessment of the collateral, are all based on the recent financial crisis, which has altered the global business cycle. The accuracy of the property valuation system, which could restore confidence in real estate financial assets and securities, plays a key role in the new financial mechanism and could contribute to making of the formation of property price process in the housing and real estate market more comprehensive (Kauko and d'Amato, 2010).

In Nigeria, most of the real estate has

traditionally been valued using traditional methods such as comparison, cost, investment, profit, and residual methods (Selim, 2008). These methods are still useful for valuing single properties. However, it is argued in the literature that they are inefficient for valuing a large number of properties. As a result, a paradigm shift to more reliable methods of valuing properties is required. As a result, new approaches and techniques for mass real estate appraisal have been introduced. Using a manual valuation method may sometimes contribute or produce a poor-quality result due to the problem of huge numbers of properties and the massive amount of data involved. Besides that, is very tedious, time-consuming, and high cost (Dzurlkanian, et al., 2006). For mass appraisal, a group of properties will be valued at once by taking into consideration all comparable available and to be completed on time and use or applied in valuing a huge number of properties.

The use of computer technology, mathematical statistic, and geographic information technology to create the mathematical model that reveals their market value and serves as a systematic appraisal of a group of real estate properties is known as mass appraisal, or automatic valuation of real estate assets (Zhou, Ji, Chen, & Zhang, 2018). For property information management, valuations, owner notifications, and taxation credibility security via uniform valuation procedures, CAMA (Computer Assisted Mass Appraisal) systems are automated systems used. The significance of prediction accuracy in computer-assisted mass appraisal (CAMA) has long been debated, particularly in the areas of model explain ability and assessed value defensibility. In the last two decades, the development of alternative automated valuation methods to support price estimation has grown in popularity (Lin & Mohan, 2011).

CAMA systems evaluate property values using statistical methods (e.g., Multiple Regression Analysis) and control of computer assisted (IAAO, 2013). They can function independently or as part of a larger fiscal system. A CAMA system, according to McCluskey et al. (1997) must depict the demand and supply levels of the market in which single property is located. CAMA systems should be used when a resource is adequate, valuation completion time is critical, objectivity and uniformity are desired, and the number of properties is large, and its classified into two broad categories: traditional and contemporary. Techniques in the traditional category comprise Multiple Regression Analysis, Comparable Sales Analysis, Adaptive Estimation Procedure, and Indexation, whereas Artificial Neural Networks, Random Forest, and Expert Systems are among the contemporary categories. Mass appraisal systems should meet two requirements that include achieving accuracy predictive capability satisfactory level and provide adequate predicted property values elucidation and justification (McCluskey et al., 1997). Finally, the valuation technique uses is determined by the data availability and characteristics, value basis, and the valuation purpose (McCluskey et al., 1997; McCluskey, and Borst, 1997; Ibrahim et al., 2021).

The development of a valuation model capable of replicating the forces of supply and demand over a large area is required for mass appraisal. A mass appraisal can develop a valuation model that is applicable in valuing a large number of properties for a specific type of property in a specific area by using a computerized system.

McCluskey and Adair (1997) as cited by Ibrahm et al., (2021) stated that the goal of developing a valuation model is to evaluate several properties to generate accurate estimates that consider supply and demand factors in the area. Considerations on the value of a group of properties necessitate appraisal skills to build, support, and explain the adjustments made in the valuation model, such as land use factors, building types, locations, property types, and other factors considered. Individual property assessments may be conducted as part of mass appraisal, but the primary goal of mass appraisal is to evaluate many properties at once. It's at these backgrounds the study seeks to review Multiple Regression Analysis, Artificial Neural Networks, Random Forest as among the valuation modern techniques to serve as substitute of traditional valuation methods in Nigerian real estate profession to as new techniques for valuation purposes. The paper critically reviews these three methods and explained how those methods employed in valuation purposes in real estate professions by others developed and developing countries and get the yielding results in valuation purposes. The findings highlight the details explanation of these three methods and how they employed in property valuation using mass appraisal to serve as guidelines on how to be employ in Nigerian real estate.

## 1.1 Statement of Research Problems

In Nigeria, most of the real estate has traditionally been valued using traditional methods such as comparison, cost, investment, profit, and residual methods (Selim, 2008). These methods are still useful for valuing single properties. However, it is argued in the literature that they are inefficient for valuing a large number of properties. As a result, a paradigm shift to more reliable methods of valuing properties is required. As a result, new approaches and techniques for mass real estate appraisal have been introduced. Using a manual valuation method may sometimes contribute or produce a poor-quality result due to the problem of huge numbers of properties and the massive amount of data involved. Besides that, is very tedious, time-consuming, and high cost (Dzurlkanian, et al., 2006). For mass appraisal, a group of properties will be valued at once by taking into consideration all comparable available and to be completed on time and use or applied in valuing a huge number of properties. At such this study seek to review three different methods to serve as replacement of traditional methods of valuation in Nigerian real estate profession

## 1.2 Objectives of the study

i. To review Multiple Regression Analysis, Artificial Neural Networks, and Random Forest as valuation modern techniques in Nigerian real estate profession

## 2.0 LITERATURE REVIEW

Mass Appraisal (MA) is a group of property systematic appraisal as of a given data via statistical testing, and homogenous procedures (Eckert, 1990; Auwal et, al., 2018; Ibrahim, et al 2021). Mass appraisal is also defined as "the process of valuing a universe of properties as of a given date using standard methodology, common data, and statistical testing" (Appraisal Foundation, 2014). Similarly, FLCSR (2001) stated that "mass valuation of real estate is defined as a systematic valuation of groups of real estate units performed on a specific date using standard procedures and statistical analysis, whereas individual valuation is concerned with determining the value of individual property units." Compared to single valuations, the mass appraisal model incorporates more

terms because models try to replicate requirements and supplies of one or more markets or land uses throughout a wide geographical area (Eckert et al., 1990). The mass appraisal therefore includes developing an appropriate model consisting of standard methods and adequate statistical tests that can demonstrate the model's capacity and reliability in property pricing estimation. When at the same time many properties must be valued, such as for calculating annual assessment value, a mass appraisal is needed (IAAO, 2014). Mass valuation is useful for various purposes, including taxes, price index construction and understanding of the operations of the property market (Jahanshiry et al., 2011).

## 3.1 Methodology

To achieve study objectives, Secondary source of data collection was employed, a thorough review of relevant materials was employed, where various relevant materials were downloaded and review to come on how mass appraisal is useful for various purposes in real estate. Different journals and articles was and peer reviewed was done after gathering of materials, where relevant materials for a period of 5 t0 10 years and those within the different region was selected and included and all those beyond these years was excluded.

## 3.2 Data Analysis

Data was analyzed through reviewing of various previous research by different scholars on how CAMA can be used in real estate profession based on MRA, ANN and RF.

## 4.0 Data Presentation and Analysis

### 4. 1 Multiple Regression Analysis

Multiple regression analysis is a practical extension of the model that has been observed and allows the creation of a model with many independent variables (Dielman, 2011). Gallimore et al., (1996) described the multiple regression analysis (MRA) as a technique that seeks to link the value of several independent variables to a further variable whose value is supposedly dependent on the dependent variable.
MRA includes a variable to be explained as the

dependent variable and additional explanatory variables that are assumed to produce or be correlated with changes in the dependent variable (Rubinfield, 2011). To construct a valuation model, MRA required a set of data that included a dependent variable in terms of a quantitative variable and more than one independent variable.

MRA has been widely used in international countries such as the United States, Australia, the United Kingdom, Sweden, Northern Ireland, Tasmania, New Zealand, Hong Kong, and Singapore (Eckert, 1990; Dziauddin & Idris 2017). Eckert et al., (1993) pointed out that many of these countries applying the MRA in the mass appraisal are for tax purposes, but recently the MRA is useful in other contexts, including the analysis of the mortgage loan portfolio.

Benjamin et al., (2004) suggested that multiple regression analysis is used to test theories about the relationship between a dependent variable and two or more independent variables and to make assumptions about the dependent variable. This is the reason and usefulness of the statistical technique to assess the selling price or the value of the property.

Pagourtzi et al., (2003), explained that the general multiple regression models which summarized as follows:

$Y = a + b_1X_1 = b_2X_2 + \ldots\ldots\ldots + b_nX_n + e$, where

Y = dependent variable

$X_1, X_2 X_n = $ Independent variables

a = Constant

$b_1b_2b_n$ = Coefficient of regression

e = the error term is uncorrelated with one another

n = number of variables included in the equation.

### 4.1.1 Procedure in Developing Multiple Regression Analysis Model

Data collection is the first step in constructing multiple regression models. The data collection criteria for the development of a multiple regression model vary with the nature of the study. The baseline data collected must be correct to move on to the next steps. If the data has been collected, the data checks should be carried out to identify the raw data error.

The second stage is the specification of the model. The dependent variables and independent variables to be used in the valuation model will be defined in this stage. Normally, the price will be the dependent variable, while independent variables will be the factors that affect the price. The model specification means the determination of which independent variables should be included or excluded from the regression equation (Allen, 1997). Independent variables may be first-order or second-order terms, interaction terms, and dummy variables (Theresa, 2012). Theresa (2012) also stated that the step-by-step regression and all-possible-regression selection process helping in picking the most appropriate variables that relate toward the response variable. Also, Allen (1997) in his view stated that two basic types of specification errors that miss specify the model by including in the regression equation an independent variable that is theoretically irrelevant and miss specify the model by removing from the regression equation an independent variable that is theoretically relevant. The baseline valuation model will be built in this step.

The next step is a validation of the model. when applied to a new set of data, the models that suit well the sample data may not be statistically useful due to changes or unpredictable events that may occur. The validation of the model performance is very important when checking model adequacy (Theresa, 2012).

Once a baseline model has been developed, statistical tests must be carried out to validate the model relationship to provide a good description of the data. Statistical tests such as t-test, F-test, $R^2$, adjusted $R^2$, multi-collinearity, and dispersion coefficient. After statistical tests have been carried out, if the outcome was not sufficient, the model must be calibrated to achieve a more accurate outcome (Research into Action 2011).

The next step is the calibration of the model. The calibration described by Mustafa (2004) is important to achieve consistency of measurements. Calibration also involves creating a relationship between the response of the instrument and one or more reference values. Model calibration is the method of adjusting mass appraisal formulas, tables, and schedules for the current market. Calibration may be done using automatic calibration or manual calibration to adjust the regression model.

This calibration process was carried out when a thumb of the rule was not achieved by the adjusted $R^2$ as more than 80 percent implies that the model developed was not suitable to be used as a valuation model in the valuation of the residential properties. This problem of low adjusted $R^2$ can be solved by removing the outlier in the transaction data (Auwal et al.,

2018).

Besides, to observe the relationship between independent variables, the multicollinearity process should be conducted as if there were strong relationships or multi-collinearity, one of the independent variables must be excluded from the valuation model. Once the outliers and multicollinearity variables have been excluded, the MRA process will rerun, and a new valuation model will be established. This is a model calibration process.

Model development is the last step. The new valuation model will be built to indicate the relationship between independent and dependent variables after all statistical tests have been conducted, dependent and independent variables have been identified. This valuation model should also be observed the adjusted $R^2$ which is more than 80 percent, if adjusted $R^2$ is appropriate, then this MRA model was considered accurate and can be applied to the case study in valuing the residential building. Otherwise, the calibration must be carried out until the result of the modified R2 achieves the 80 percent accuracy level (Eckert et al., 1993).

## 4. 1.2 Multiple Regression Analysis in Real Estate.

As a statistical tool, MRA has provided several advantages or benefits in the execution of the valuation process. First of all, it can be used to explore the extent to which factors or independent variables affect the dependent variable. Multiple regression analysis can be used simultaneously to determine the dimension of the dependent variable using a group of explanatory variables (Clowell et al., 2009).

Bahar et al., (2011) also indicated that MRA is a technique that can be used to test the explanatory variable independently for analysis towards the dependant variables influence of each factor assessing. Following the above statement, MRA is believed to be a useful tool to enhance the understanding of property attributes that drive property values.

MRA is often used as a tool to predict the value of unknown variables (dependent variables) by using known variables (explanatory variables). Martin (2009) claimed that MRA can be used as a predictive tool to estimate the price of real estate which is a relatively homogeneous type in an efficient market. According to Kutner (2004), MRA is one of the most commonly used statistical techniques to analyse data to define, control, and forecast the value of a single variable.

Another advantage of MRA is the accuracy of the output in the valuation process. Adair and McGrell (1988) mentioned that the MRA can provide an accurate result in a very quick assessment of the values of a large number of properties. Dzullkarnian et al., (2006) also noted that it is becoming increasingly necessary for MRA to be able to demonstrate the high degree of accuracy within a short time.

In providing the precision value of the property or dependent variables, the accuracy of the MRA output is undeniable. Some statistics should be carried out to assess the accuracy of the valuation model construct, such as the t-test, F-test, R2, modified R2, and multicollinearity test, by evaluating the accuracy of MRA.

Moreover, MRA offers versatility and conceptual consistency in the valuation process. MRA can increase the statistical power against error and have more thoughtful hypotheses about the data. By ignoring the unnecessary test and more specific hypotheses created, MRA can be used to counter the error (Thompson 2006).

Furthermore, MRA can also understand where the variables are statistically significant and examine the trend in data, such as determining the outlier of the variables. Furthermore, MRA can perform the MRA method by the use of continuous and nominal independent variables. In short, the clear and useful information to be interpreted in solving the problems facing valuation was provided by MRA.

Also, MRA has benefits in terms of simplicity and computation. To develop a valuation model in determining the value of a dependent variable, MRA can be performed integrated with computed assisted known as CAMA system. According to Griffith (2010), the valuation model can be replicated using the CAMA system to assign value to the different features of a property and then applied to all properties to ensure that all properties are treated equitably. Furthermore, MRA is considered simple because the output can be easily interpreted, and trivial or unimportant output can be ignored without affecting another implementation.

## 4.2 Artificial *Neural Network Model:*

NN (neural network) is a data-processing model that can uncover and track relationships between different data sets on its own (Yasmin Zainun, 2004). It is the artificial intelligence model that simulates a human brain learning process. Neurons in the brain

are the basic processing units that receive and send signals to many nervous system channels throughout the human body (Lai, 2006). A neural network is essentially an information-processing model that is designed to discover and track the relationships between various data sets on its own. Carnillo Golgi's neural cells detection in the brain in 1836, which earned him the Nobel Prize in physiology or medicine, is a todays Artificial Neuron cornerstone which is the foundation of Artificial Neural Network Analysis.

Julia, Jose, and Francisco, (2013) explained that in 1943 McCulloch and Pitts pioneered ANN models as an alternative to algorithmic programming, building on earlier work by Karl Lashley in the 1920s. According to Rumelhart and McClelland (1986), ANN is a set of operators or neurons with a small amount of storage capacity connected numerically one-way by links called axons. Nodes operate on limited data supplied by neuron and weighted with some parameters WIJ, which connect axons I and j. A propagation rule specifies in what way a neuron's inputs are valued and processed. The fundamental model consists of an input layer, one or more hidden layers formed by non-observable variables, and an output layer containing the dependent variables. Neural networks are utilized for a variety of tasks, including model estimation, classification, and forecasting (Julia, Jose, and Francisco, 2013).

In general, ANN is a human neural brain segmentation processing data paradigm that is based on the human biological system. A certain cell sort known as neuron is the most basic component of a human brain. NN is essentially the information-processing model that is planned to discover and track the relationships between numerous data sets on its own. In 1950s, they were created, and they are known as AIS (Artificial Intelligent Systems) (Bakhary, 2001). Most of the neural networks basic components are modelled after the brain structure. Some neural network structures are not closely related to the brain and have no biological counterpart in the brain. However, because neural networks are so like the biological brain, terminologies use mostly are borrowed from neuroscience. Thinking, remembering, and previous experience applying to every action are among the function of human brain fundamental component, all these are allowed mostly by these specific types of cells. Neurons are the general name given to these fundamental components (cell) and these cells are able to communicate with almost 200,000

other neurons. A brain power is derived on these specific cell type and the numerous connections that exist between them (Raicevic, and Johansson, 2001). If the input experience was detected by the body, the nervous system sends numerous messages to the brain that describe an input. Information from these input signals is interpreted by the brain's neurons via synapses, which combine and transform the data. When all the information has been processed, a response is generated. Also, brain learns the optimal processing and reaction towards inputting over stimuli replication and responses feedback. The exact process of learning in the brain is still a biological obscure; it is clearly that learning occurs and recurs via the repetition of input stimuli and output responses. Dendrites, soma, axons, and synapses are among the four (4) natural neurons components. In essence, input from other sources were received by biological neuron, it joints them in some way, and accomplish a generally nonlinear operation on the result, and then be an output.
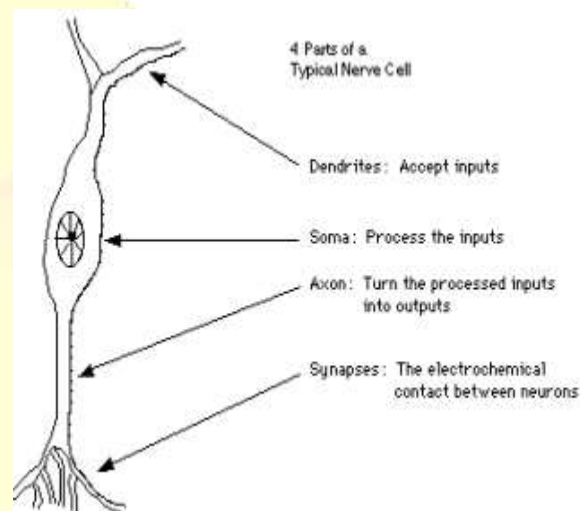


**Figure one: Biological Neuron Simplify.**
Source: Adapted from Hussein Arsham, 2001 Artificial neurons, the basic unit of neural networks, imitate the 4 genuine neuron basic functions. The artificial neuron is considerably easier to understand compare to biological neuron.

$$I = \sum w_i x_i \quad \text{Summation}$$
$$Y = f(I) \quad \text{Transfer}$$
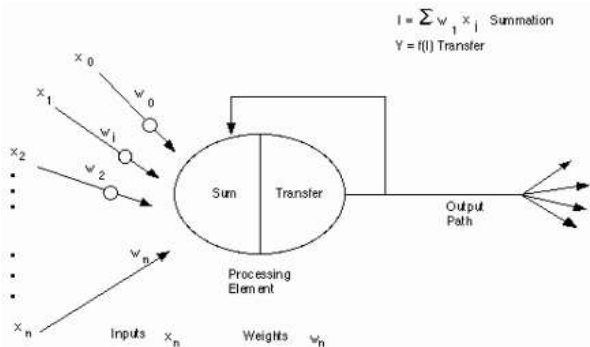
**Figure Two; Artificial Neuron Basics**

It is worth noting that the mathematical symbol x is used to represent various "N" (network inputs). Connection weight denoted by "W". "N" is used to multiply each of these inputs. The result output will come out then after these products are simply added together through a transfer function (Panowitz, 2001).

Basically, there are three layers of artificial neuron network, while sometimes it can be more than three layers. Input layers that are made up of neurons received from the external environment was the first layer. The second layer was the output layer, which consist of neurons that communicate the output from the system to the external environment or user. Neurons will produce output if an input layer sends the input to the next layer which becomes system's other layers input. The procedure is repeated until certain criteria are met (Yasmin, 2004). The neurons in the figure below are organized based on layers. The input layer is made up of neurons that receive input from the outside world. The output layer produced neurons that communicate to the user output system or the outside world. Normally, between the two layers, there are several hidden layers.
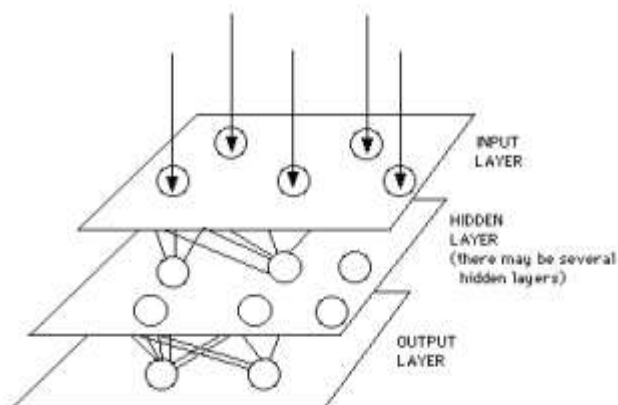


**Figure Three; Simple Structure Network**

Source: Reviewed from Hussein Arsham, 2001

Yusof (2006) in his view stated that before creating an output, apiece neuron in the layer must communicate with other input in the next layer and establish the best possible relationship between the neurons. The greater the number of connections between neurons, the easier it is to train them. The procedure of putting raw data into the system so that it can learn and memorize the information among inputs through a learning role is referred to as training. Among the neural network model itemizations that need to know in other to operate a network includes learning algorithm, weights and biases, summation function, activation function, learning rate, and momentum rate (Yasmin, 2004).

Zainun (2009) stated that if the input was received by the input layer, the output will be produced via its neurons and it becomes other layers system input. The process will continue repeating pending to the meeting of the condition or till the invoked of output layer and send its output to the external environment. The trial-and-error method is used to determine the number of hidden neurons that the network should have in order to perform optimally. The network will become overfit and have a difficulty generalization where a hidden neuron is too large. Since the data set training to be memorized, the network will be unusable on new data sets. The network is presented by the data through learning role so that it can be learn and memorized the data among the inputs. Through supervised or unsupervised environment, the learning will take place.

The network is given the definite outputs to compare output values created in supervised learning, which will allow the network to notice the differences and modify. The weights of the arcs between the nodes are changed using learning algorithm, to reduce the disparity among the produced and actual values. To achieved further reduction after that, the network will receive a new input and continues the cycle. While the desired output for comparison is not given by the network in unsupervised learning. For it to discover connections and relationships within the data on its own the learning process entails feeding the network a large amount of data input and thus differentiate the various patterns for identification.

Zainun, (2019) also noted that the appropriately designed neural network includes a 'self-training' mechanism that permits it to analyse virtually data amounts incomprehensible, test for and discover relationships or connections among the data and use these discoveries with its programmed formulas to make predictions

about future trends or events. Based on this, ANNs is set apart and got much attention both in academic and business. Like a person learn over time by modifying its formulae to lessen future disparities between forecasted and real results, the projected result from ANN may also be compare to actual results.

Fischer (1992) stated that the processing elements are usually divided into three "levels" (layers): an input layer, one or more intermediate (so-called hidden) layer(s), and an output layer. The below figure depicts a neural network with three layers of processing units, which is a common organization for the popular back-error-propagation neural network architecture. The input pattern values represented as a vector which is input to the network are assumed by the processing input layer units. The processing components that accept and transmit the input signals make up the intermediate layer. There may be extra than one intermediate layer in some cases. These intermediate layer processors are linked to the output layer's output neurons.
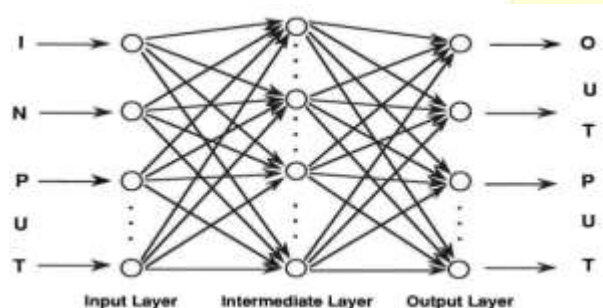


**Figure Four; Three Fully Interconnected Layers of an ANN**
Source: Adapted from Fischer, 1992

Every connection among processing elements serves as a communication path. Numeric values are passed from one processor to the next via these interconnections. They are weighted by the connection strengths associated with each interconnection and are adjusted during training to produce the final neural network.

## 4.2.1 *Back-Propagation Network in Neural Network (BPNN)*

Back propagation, often known as back-pro, is the most popular and commonly used neural network paradigm (Zainun, 2019; Bohkha, 1996). According to Rumelhart and McClelland (1986), supervised feedback neural network is a BPNN, because of its capacity to handle nonlinear issues, and for forecasting of time series it also been used and multiple regression and many other fields. In BPNN, there are two methods for error

propagation that include learning and mapping. The data travels from the inputs to the output layers in mapping mode. The information flow by the learning mode fill-in between forward and backward. The error signal travels backwards in the network as the difference between the output and the target output. The connections are modified in response to the error signal, resulting in a lesser error the next time the network receives the same input. There are three layers in BPNN that include input layer, hidden layer and output layers.
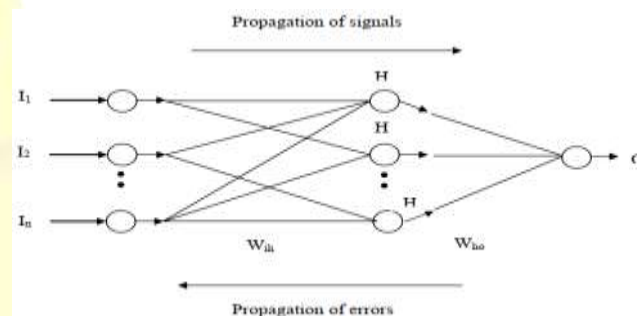


**Figure Five; Back Propagation Neural Network (BPNN).**
Source; Adapted from Zainun, 2019.
NOTE: at the above figure, Input layers symbolizes I, while the hidden layers symbolize H, output layers symbolize O, weighted matrix linking the input nodes to the hidden nodes symbolize $W_{ih}$, and the weighted matrix connecting the hidden nodes to the output nodes symbolize $W_{ho}$.

## 4.2.2 ANN in Real Estate

In the property valuation, the use of artificial neuron network was traced back in the early 1990s (Rotimi and Albert, 2017). In 1991, Borst remained the first to use the ANN technique in real estate appraisal. The ANN technique explanation was presented by the study and investigated the ANN model predictive accuracy in four different circumstances using different network architecture. The study concluded that forecasting ANN accuracy model is reliable, and the model would produce outstanding results by more research efforts directed on the ANN application in real estate appraisal. Difference studies was applied ANN in Real Estate profession after Borst 1991 for various valuation purposes which yield an accuracy result.

Mora-Esperanza (2004) stated that in real estate valuation, ANN is typically working with variables ranging from 10 to 50. On the other

hand, the input neurons number must be proportional to the variable's numbers. Although hidden layers input number and neurons can be varied, existing literature indicates that at least one hidden layer with the number of neurons specified in the model is effective (Lokshina, et. al., 2003). In the same vein, ANN experts frequently use the following property characteristics and attributes as useful variables in real estate valuation. These are the number of bedrooms, the size of the building, the age of the building, the size of the land, the position convenience (main road or city centre distances) and building materials quality. Parking facilities, road type, number of toilets and bathrooms, building floors numbers, space arrangement, physical condition, attractiveness of the neighbourhood, house interior, structural quality, recreational facilities, among others are among the other useful variables (Lokshina et, al., 2003; Parscharayanich et, al., 2000).
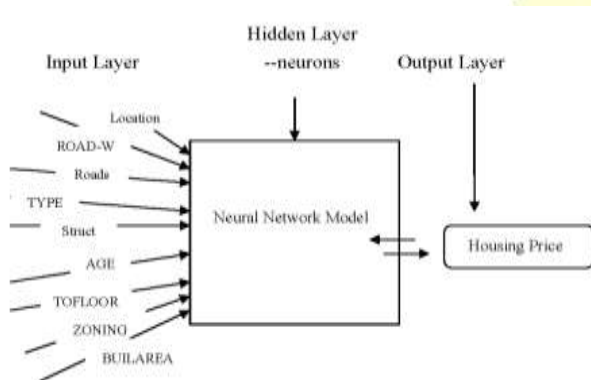


**Figure Six; neural network model in real estate**
Source: Adapted from Lai, 2006
The three layers of nodes are depicted in the diagram above: the input layer, the hidden layer, and the output layer. The input layer contains data from explanatory or independent variable measures. The data is passed from the hidden layers' nodes to the output layer, which represents the dependent variables. A nonlinear transfer function weights information as it passes through the hidden layer nodes, simulating the transformation of information as it passes through synapses in the brain. The artificial neural network model's goal is to demonstrate the true relationship that exists between the input, independent variables, and the output, or dependent variables.

## 4.3 Random Forest

Random Forest (RF) is a collection of decision trees created using a particularly efficient strategy aimed at increasing the diversity of the trees (Granitto et al., 2007). RF is an ensemble learning method based on the decision trees (DTs) (Breiman, 2001; Ho, 1995) that necessitates supervised training. As a result, training dataset containing response and explanatory factors is required. The DT is created by recursively splitting the samples depending on the significance and effectiveness of the variables in the training data set using the growing tree technique (Fan et al., 2006). The construction of DTs begins at the tree's root node and continues down to internal nodes and the latter part of the leaves (Granitto et al., 2007; Quinlan, 1986).

Decision trees (DTs) are decision support tools based on tree-like graph models, with each branch representing a decision result and its threshold. Assume that a node has a branch based on a feature C with a threshold N. If the feature C of a new sample is less than N, it takes the left branch; otherwise, it takes the right (Jengie, Heeyoul, and Woo-Sung, 2020). Classification or regression models are created by DTs. Each leaf node of the tree represents a class in classification models, and classification is based on following the branches from the root node to a leaf node. As in classification, regression is based on local linear regression in divided subspaces defined by leaf nodes after following the branches. To train trees, one feature and one threshold should be chosen at a time to create a branch at a node, with similar samples on each branch following the split. There are a few metrics to consider when selecting a feature for a new branch, including standard deviation reduction. The depth of the tree is increased by adding one additional node at a time Jengie, Heeyoul, and Woo-Sung, 2020).

Jengie, Heeyoul, and Woo-Sung, (2020) explained that RF is a group of DTs that makes a forecast by average in the case of regression) the predictions generated by each tree in the group using some input data. RF starts with the trees when provided training data. The following algorithm is used to build all of the trees in the ensemble individually. Let X stand for the entire collection of predictors. To grow each tree using a bootstrap sample of the training data, a subset of X, randomly chosen predictors, is employed. A non-pruned regression tree is created for each of the bootstrap samples. Predictions are averaged across all trees when a large number of trees have been formed.
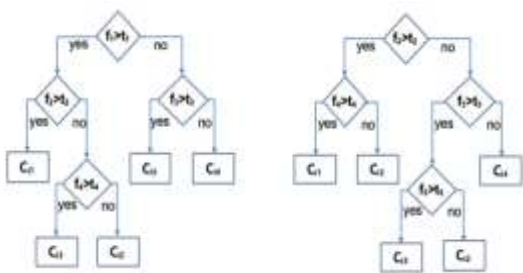
**Figure Seven; Two decision trees (DTs) assemble with four to five features depth as an example of RF.**

(Adopted from Jengie, Heeyoul, and Woo-Sung, (2020)

According to Jengie, Heeyoul, and Woo-Sung, (2020) random forest techniques can be useful in predicting the value of a property. RF also can deal with nonlinear links and the variable influence unsteadiness across different segments. RF is better suited to dealing with level of complexity that did not deal by many different mass appraisal methods. The interpretability of the trained model is also determined by DTs and RFs: persons can understand how the trained model works. Trees are also easier to train and make faster inferences than other machine learning algorithms. DTs number and tree depth are the only two hyperparameters to train RF models. The computation cost is more stable with more DTs, and by dividing the sample space into smaller parts, deeper trees find more accurate results which may lead to overfitting.

Decision trees are very unstable methods, which means that a minor change in the dataset can result in large changes in the developed model (Breiman, 1996). Then, to increase the diversity of the ensemble members, RF fits each tree on a bootstrap replicate of the entire set of samples. A bootstrap replicate (Granitto et al., 2007; Efron & Tibshirani, 1983) is a random subset of the available dataset of the same length that is taken with replacement (i.e., each sample is chosen at random from the full original dataset regardless of whether it has been chosen previously). Through the growth of each tree, a second source of diversity is introduced. The method selects a small random subset of m attributes (from the total M attributes available) for each node and searches for the best split using only this subset. The combination of these two sources of diversity (fitting on bootstraps plus selecting only from a subset of attributes at each node) results in easy-to-build ensembles with excellent prediction performance.

Granitto et al., 2007 stated that Controlling

overfitting is one of the most important properties of RF, even when ensembles contain thousands of individual trees. When the number of trees is infinite, its error rate on unseen samples shows a smooth convergence to a limiting value. In practice, the RF algorithm has only one free parameter, the number m of attributes made available at each node during tree growth. However, as Breiman (2001) demonstrated, its results are not strongly dependent on this parameter, and the default value of m (the square root of the total number of attributes M) usually yields near optimal results.

Marjan et al., (2018) stated that the RF regression approach, regression trees are utilized as base learners. Each regression tree is generated using a different bootstrap sample derived from the initial training data after the number of trees in the forest has been determined. A binary test against the selected predictor variable is represented by each node in a tree. There are no more than the given maximum number of samples in terminal nodes from which the target value is calculated by averaging. To avoid high correlations among the trees in a forest, a technique for selecting the best splitting predictor in each node of a tree is changed to choose amongst only m randomly picked predictors, resulting in the selection of a random subspace of the original n-dimensional issue. The R package random uses a fixed parameter, m (m n), to generate random numbers. When dealing with regression difficulties, Forest defaults to m = n/3 (Liwa and Wiener, 2002). Running down both branches for instances, the variable is chosen to minimize the residual sum of squares (left and right). See below figure.



$$\{ (X, Y) \mid X = (x_1, x_2, \ldots, x_n), Y = f(X) \}$$

$$x_i > t \quad t\text{-}treshold\ value$$

$$left \quad right$$

$$L = \{( X, Y \mid x_i > t, Y = f(X))\} \quad R = \{( X, Y \mid x_i \leq t, Y = f(X))\}$$

$$Y_{left} = \frac{1}{|L|} \sum_{(X,Y) \in L} Y \quad Y_{right} = \frac{1}{|R|} \sum_{(X,Y) \in R} Y$$

$$RSS = \sum_{(X,Y) \in L} (Y - Y_{left})^2 + \sum_{(X,Y) \in R} (Y - Y_{right})^2$$
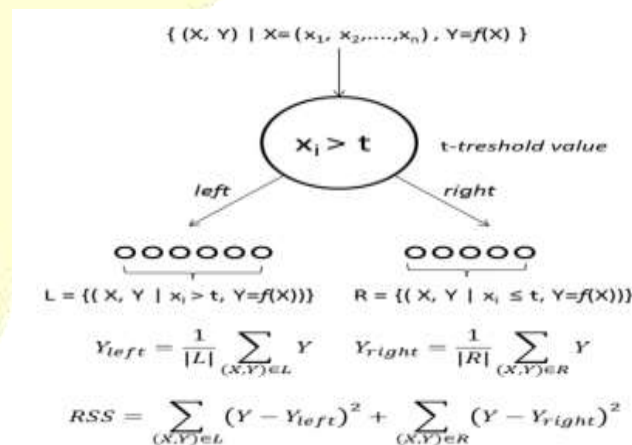
**Figure Eight; Random Forest Regression Approach**

### 4.3.1 Random Forest in Real Estate

Zeffora, and Shobarani, (2019), stated that the accuracy of the Random Forest model in estimating residential property prices has been used in various parts of the world. They also investigated the effects on average forecast error when outliers were removed from both the test and training datasets. The study found that when outliers are removed from the data set, the RF model performs well in predicting the value property. It is worth noting that the absolute error was averaged. Nonetheless, not all studies have reported positive or favourable outcomes from the application of this technique. Several authors reviewed a number of these project studies and presented a paradigm of what can happen when various RF models are used to predict the value of real estate properties. According to the findings, the best random forest models are purely dependent on the time period and data sets used. They also discovered that when the same data sets are merged with different model settings, the outcomes can change. As a result, it is advised that researchers use caution when developing and applying random forest networks to real estate value appraisal. In many previous studies on mass appraisal, models based on nonparametric methods, such as neural networks or support vector machines, outperformed OLS-based models in terms of predictive power. There appear to be significant market complexities that cannot be fully explained by the traditional hedonic pricing model. RF is better suited to dealing with this level of complexity.

### 5.0 CONCLUSION

Statistical Package for Social Sciences (SPSS) is a software work with several kinds of computer files, output files, and syntax files. For types of windows will be encountered while using SPSS which include data editor window, output viewer window, chart editor window, and syntax editor window (Garba & Finn, 2005). The main aim of using mass appraisal is to value many properties fast and accurate. In many countries both developed and developing countries CAMA using deference modern techniques such MRA, ANN, random forest among others was applied and produced yield results in real estate profession. In Nigeria there is need of introducing these modern techniques in valuation purposes by avoiding time consuming, high cost and producing a poor-quality result due to problem of huge numbers of properties and massive amount of data involved because of using traditional methods of valuation.

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# ASSESSMENT OF THE COMPLIANCE OF DEVELOPMENT CONTROL IN ZURU TOWN, KEBBI STATE, NIGERIA

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## ABSTRACT

*The study aimed at assessing the level of developers compliance on the development control in Zuru town. To achieved this aimed two objectives was achieved which are (i) to examine the awareness of the development control in Zuru town and (ii) to assess the level of compliance of the development control in the study area. both primary and secondary sources of data collection were adopted as sources of data collection. Property owners in Zuru town was used as the study population. 400 questionnaires were administered. And 387 were able to be retrieved. The findings of the paper revealed that Room size, building height, and plot coverage has the least compliance in the study area. Compliance on the provision of ventilation adequacy has the highest compliance. The study recommended that there is need for Kebbi State government to provide a document which will serve as planning regulation instruments to use by the planning administration in the state as guidelines for the control of development in the state, and Planning authority in the state need to be well equipped with all needed facilities within the state for proper implementation of the development control in the state.*

***Keywords: Development, Control, Land, Planning, Compliance, Development Control***

## 1.0 INTRODUCTION

Land is one of the most importance for human lives, almost all his activities are carrying out on it (Ibrahim et al., 2021). Land is necessary for diverse purpose for both urban and rural areas societies. It is essential for the nation's growing and development. When the land is not used in a harmonious and orderly manner, both the urban and rural areas in nation cannot reap the full benefits of the land stock. In any country or societies, land also serve as a major factor of production and critical component of socioeconomic growth (FMH&UD, 2006). Land always has high competition for various purposes when a country developed in size, rural areas become urban centres, and urban centres become large metropolitan areas. For this, sufficient planning and management are required so as to ensure harmonic

development and functional effectiveness for various uses and settlement (Aribigbola, 2008). Cities must be prepared to accommodate new residents, which necessitates more forward-thinking measures such as updating urban planning regulations to allow for density while avoiding excessive demand for scarce housing and land (Freire, 2006).

Development controls are thus increasingly used by nations around the world to achieve effective and efficient land use (Aribigbola, 2008, Boama, et al., 2012). Land-use regulations establish the legal boundaries for both public and private land uses in each area (Arimah & Adeagbo, 2000, Boama, et al., 2012). Development control is a type of planning that involves town planners regulating and managing human activities through the Local Planning Authority (LPA). Its goal is to ensure the arranged and logical development of land, as well as the creation of sustainable developments and human settlements which will accommodate a diversity of land uses in order to suit the demands of the people who live there. Development Control is implemented using layout plans, master plans, environmental impact assessments (EIA), zoning and zoning rules, and other tools (Jimoh, Al-Hassan, Imimole, and Ahmed, 2017)

African countries that include Sahara and Sub-Sahara development control has been criticized as providing little benefit to the people (Boamah, Gyimah, and Nelson, 2012). According to Arimah and Adeagbo (2000), plot coverage ratio compliance is poor in high-quality residential neighbourhoods, medium-class areas violate zoning restrictions, and low-income neighbourhoods have no plot coverage ratio compliance.

The continual increase in human population has been demonstrated as the equivalent outcome of expanding urban sprawl around most cities. People begin to build structures in order to protect themselves and their families without contacting any local authorities. The few developers who may be consulted may not follow the protocol in its entirety. However, several regulating mechanisms are in place, directed by a plan, to encourage effective use of urban areas, enforce physical development standards, and provide a balanced spatial distribution of human activities. These mechanisms ensure that urban activities are structured in space with aesthetic, health, safety, convenience, efficiency and energy conservation, environmental quality, and social equality in mind (Amler & Betke, 1999; Avogo, 2015).

## 1.1 Statement of Research Problems

Zuru city, headquarters of Zuru Emirates are among the cities that been congested due to migration of neighbouring villages surrounding it, the migration of people due to the activities of terrorisms (Kidnapers) that use to come and burned their villages killed and kidnaped them for collection of ransom which resulting peoples from that villages living their towns sprawling endlessly into Zuru with the desires to be secured against the terrorist activities where some are migrating for getting better lives with dire consequences for the provision of essential urban infrastructure. The rate of expansion or development growth in the town led to emergence of uncoordinated land uses, traffic congestion, winding road network, among others. Rapid growth of the city needs to be controlled to prevent disordered and haphazard physical growth and development, and it can be controlled if the developers are fully aware and abide by the development control. It is at this background, this study aimed to assess the level of compliance of the development control in Zuru town.

## 1.2 Objectives of the study

i. To examine the level of awareness of the development control in the study area

ii. To access the level of compliance of the development control in the study area

## 2.0 LITERATURE REVIEW
### 2.1 The word *The Development and Development Control*

Development has been characterized in a variety of ways by different persons, based on their academic backgrounds. Development means the process of making changes in the physical environment and the changes could be good or bad. (Waziri, 2006). Development is the amount of country resources brought into full productive use by an area (Fellmann, et, al., 2005). British Town and Country Planning Act 1963 Section 12 sees Development as carrying out of building, engineering, mining, or other operations in, on, over, or under land, or the making of any material change in the use of any building or other land.

Development control refers to a physical planning tool that generally entails rules, retraining, and maintaining order, as well as monitoring changes in land materials (Ogundele, Ayo, Odewumi, and Aigbe, 2011). Aluko (2011) Define development control as a technique for maintaining standards. It is a legal mechanism that governs land development and structures. Development control also refers to town planners professional task adopted to ensure all developments are in accordance with areas master plan and maintain properly. Kebbles (1961) Sees development control as the process ensuring that zoning and subdivision regulation are complies with by the developers, all plans prepared of both land private and public sector developers in respect of land development are, examined by the planning authorities to determine what the consequences of allowing their implementation would be to occupier of the property and users nearby land. Development control is the process by which a planning authority utilizes its statutory powers in regulating development within its jurisdiction in line with the requirements of development control plans/plans regulations (Waziri, 2006).

## 2.2 Development control mechanisms

1). *Development Plan and Planning Scheme:* The terms planning scheme and development plan are interchangeable (Planning Aid for Scotland, 2013; Jimoh, et. Al., 2017). PS (Planning Scheme) is a legal document that outlines the goals, policies, and procedures for the use, development, and protection of land in the area to which it applies. A planning scheme uses planning provisions to regulate the use and development of land in order to attain certain objectives and policies (Victoria State Government, 1998). On the other hand, a development plan is a document that outlines how locations should evolve and what they might look like in the future. It specifies which types of development should take place there and which regions should not. Maps- working drawings, sketches, and diagrams that show the town's size, boundaries, direction, and features, as well as the town's growth trajectory; written document or report that lays out the objectives, policies, and provisions, such as zoning ordinances, that explain when and how to implement the plan.

2). *Planning Standards:* It has two primary section "Prescriptive Standard" and "Regulatory Standard". Prescriptive standards are guidelines or specifications used to reduce catastrophe dimension risk or any other development plan. Planning standards are used as imitations standard model in town planning. They are legally mandated standards that are in most cases rigid and inflexible. Through development control negative effects of physical developments are reduced; it is a delicate activity that requires caution, firmness, and a strong sense of responsibility on the part of the authority in charge (Aluko, 2011).

Robert, 1975 as cited by Jimh et., al., (2017) stated that Planning standards are devices that specify the percentage of coverage of all developments—housing, structures, and roads—as well as the setbacks and density of dwellings. They are classified into two categories: prescriptive and regulatory standards.

Prescriptive norms specify which amenities may be supplied at specific sites in order to avoid conflicts and foster peaceful and positive inter-relationships (Adeyeye, 2010). Regulatory guidelines ensure that houses and compounds have enough sunshine, ventilation, sunlight, and parking. They are setbacks that serve as instruments or specifications prior to the law's approval of building operations.

## 3.1 Study Area & Methodology

Zuru town as headquarters of Zuru Emirates (one of the four emirates of Kebbi State) lies between paternal grid line of Longitude 44000E to 56000E and Latitude 42000N to 56000N, and it is located towards the eastern part of the state. It has an area of 653 km$^2$. It is topographically an undulating upland region 350-100m above seas level. Sudan Savanna that is shrub savanna of lone acacia trees and shrubs with grasses mainly prophetic in nature is the type of vegetation of the town. the five months period of rainfall and seven months of dry season support the development of savanna kind vegetation along river basin. The winds are predominantly NT and SW due to the passage of the interest tropical convergence zone.

For this study, primary and secondary sources of data collection were adopted as sources of data collection. Different relevant literature was reviewed as secondary source, while reconnaissance survey and opened closed questionnaires were used as primary source of data collection. Property owners in Zuru town was used as the study population. In administering questionnaire, stratified random sampling was used as method of sampling, were Zuru town was grouped in to two (based on the 2 districts within the town, Rikoto & Rafin Zuru), in which each district was divided in to four sub-groups. Where 50 questionnaires were administered to each, where 400 questionnaires were administered. And 387 were able to be retrieved.

## 3.2 Data Analysis

For respondent biodata and level of awareness of the development control, Descriptive methods were used as analysis method, while 5 points Likert scale were used to access the level of compliance of the development control in the study area.

## 4.1 Data Presentation and Analysis

### 4.1 Table 1: Demographic information of the respondents

| S/N | Variables | Options | Respondent | Percentage (%) | Total |
|---|---|---|---|---|---|
| 1 | GENDER | Male | 304 | 79 | |
| | | Female | 83 | 21 | 100 |
| 2 | AGE | Under 30 | 62 | 16 | |
| | | 31-55 | 231 | 60 | |
| | | 56 & above | 94 | 24 | 100 |
| 3 | EDUCATION | SSCE | 46 | 12 | |
| | | ND & Graduates | 221 | 57 | |
| | | Postgraduate | 52 | 13 | |
| | | Others | 68 | 18 | 100 |

Source: *Field Survey, 2022*

Table one above shows age and gender of the respondent. Out of 387 questionnaires retrieved, 304 (79%) respondents are males and 83 (21%) are females, the lowest numbers of females respondents has to do with religious and culture of the study area. 44 of males and 18 female's respondents are under 30 which represent 16% of the total numbers of questionnaire retrieved, while respondents between 30-55 years are 173 males and 58 females which represent 60% of the total number of questionnaires retrieved, and 87 males and 8 females are above 56years which

represent the 24% of the total number of questionnaires retrieved. It shows that the respondents males are more participant than female and are capable or matured enough to provide any information needed for this research.

TABLE 4.2: LEVEL OF AWARENESS OF DEVELOPMENT CONTROL

| Awareness | Respondent | Percentage (%) |
|-----------|------------|----------------|
| Yes | 245 | 63 |
| No | 142 | 37 |
| Total | 387 | 100 |

*Source: Field Survey 2022*

From the above table it shows that 63% are aware of the development control rules and regulations, while 37 are with the opinion that they are not aware of the development control rules. These has to do with lack of proper public awareness of the planning authority to the masses, or due to negligence of the people to know some of these rules provided by the government which will make our environment to be safer, healthier, and conducive for a living. And this will affect the compliance of the masses to the development control because you cannot adhere to a thing that you are not aware of it.

TABLE 4.3: WILLINGNESS TO COMPLY WITH DEVELOPMENT CONTROL

| Compliance | Respondents | Percentage (%) |
|------------|-------------|----------------|
| Yes | 241 | 62 |
| NO | 146 | 38 |
| Total | 387 | 100 |

Source: Field Survey 2022

From the above table above, it shows that that 62% of the respondent has an opinion that they are willing to comply with the development control in the study area, only 38% are not willing to comply. Based on this, it shows that most of the non-compliances in the study area are as the result of either non fully awareness of the regulation or any other factors hindering the developer to complied with the regulations, there is for the authorities

responsible for the development control to create awareness so as all the development will be in accordance with the planning within the study area.

## 4.2 Table 4.4 Level of Compliance of Development Control

| Factor | Respondent Opinion Scale | | | | | | Mean | Ranking |
|--------|------|------|------|------|------|------|--------------------|---------|
| | SC | C | PC | NC | U | Σ | X=∑ FX | |
| | 5 | 4 | 3 | 2 | 1 | | ∑F | |
| Plot Coverage | 140 | 68 | 129 | 248 | 29 | 614 | 2.55 | 9th |
| Development Permit (Planning Approval) | 405 | 448 | 105 | 18 | 04 | 980 | 4.07 | 3rd |
| Set Back Between Buildings and Road | 420 | 388 | 135 | 08 | 11 | 962 | 3.99 | 4th |
| Utilities Availabilities | 345 | 84 | 354 | 40 | 13 | 836 | 3.47 | 6th |
| Land Uses | 555 | 244 | 168 | 16 | 05 | 988 | 4.10 | 2nd |
| Building Height | 125 | 228 | 72 | 242 | 14 | 681 | 2.83 | 8th |
| Room Size | 390 | 188 | 138 | 96 | 22 | 834 | 3.46 | 7th |
| Construction Materials | 485 | 152 | 111 | 96 | 21 | 865 | 3.59 | 5th |
| Ventilation Adequacy | 865 | 256 | 12 | 00 | 00 | 1133 | 4.70 | 1st |

Note: SC (Strongly Complied), C (Complied), PC (Partially Complied), NC (Not Complied), U (Undecided).
*Source: Field Survey, 2022*

From the above table, it constructed based on the table4.3 where 62% of the respondents said they are compliance of the development control in the study area, where they were asked on their level of compliance. Development control compliance are very importance as it helps in providing conducive, healthier, and aesthetic environment, various factors that includes Plot Coverage, Development Permit (Planning Approval), Set Back Between Buildings and Road, Utilities Availabilities, Land Uses, Building Height, Room Size, and Construction Materials Ventilation Adequacy were used to access the respondents level of compliance in the study area.

Compliance on the provision of ventilation adequacy come first with 4.70 mean, it shows that most of the building are well ventilated, the buildings are in good position in bringing in fresh outdoor air and removes the contaminated indoor air to the occupants. Land uses compliance by the respondent come second with 4.10 mean, where the respondents are with the view that they are following the designation of different land uses in the study area, they

used to make their construction based on the approval by the planning authorities, Development permit comes third with total score mean of 4.07, they respondent are in the view that they complied in the seeking of the approval from the planning authorities before embarking into any construction so as to avoid the illegal or unplanned development that will cause environmental problems, nuisance, misused and land and landed property degradation in the study area.

Setback between buildings and roads come fourth position with total score means of 3.99, setback is the minimum space required between buildings, or from structure to roads, flood area, rivers among others, so as to ensures that buildings within the region can receive natural light, better air, protection of building from shadow of another, and also to ensure that the buildings are not infringe on another. Used of standard construction materials come fifth with 3.59 mean score, people are using quality materials not only to make their buildings very strong, but also to contributes to the safety, security and health to the occupant. Next in compliance by the respondent is utilities availability as sixth with 3.47 means score.

Room size, building height, and plot coverage has the least in compliance in the study area, with seventh eighth and nineth with the mean score of 3.46, 2.83 and 2.55, most of the respondent are neglecting them because of one reasons to other, the prepared to make their construction based on their needs without looking of the benefit of following standard in their building height, plot to cover and sizes of rooms for the ease of movement, ventilation and other benefit driving from implementation of them as part of the development control in the study area.

TABLE 4.5 Reasons for non Compliance

| Reasons | Respondent Opinion Scale | | | | | | Mean | Ranking |
|---|---|---|---|---|---|---|---|---|
| | SA | A | PA | D | NI | Σ | X̄=ΣFX / ΣF | |
| Human Resources Capacity | 480 | 164 | 12 | 10 | 00 | 666 | 4.56 | 1st |
| Properties Owners Ignorance | 205 | 148 | 48 | 90 | 07 | 498 | 3.41 | 5th |
| Lack of Regulation Flexibility | 335 | 120 | 72 | 16 | 17 | 560 | 3.84 | 4th |
| Corruption from Regulatory Bodies | 295 | 184 | 75 | 16 | 03 | 573 | 3.92 | 3rd |
| Political Interference | 405 | 100 | 69 | 24 | 05 | 603 | 4.13 | 2nd |
| Lack of Awareness | 135 | 16 | 96 | 152 | 07 | 406 | 2.78 | 6th |

Note: SA (Strong Agreed), A (Agreed), PA (Partially Agreed), D (Disagreed), NK (No Idea)
*Source: Field Survey,2022*

From the above table, it constructed based on the table 4.3 where 38% of the respondents said they are not willing to comply with the development control in the study area, where they were asked their reasons for non-compliance. Human Resources Capacity, Properties Owners Ignorance, Lack of Regulation Flexibility, Corruption from Regulatory Bodies, Political Interference, Lack of Awareness are among the reasons used by the researcher to access their opinion of non-compliance. Human Resources Capacity that includes level of incomes, knowledgeable, and experience of the respondent on the development control with 4.56 mean score is the first reasons of the respondent for noncompliance, then followed by the Political Interference with mean score of 4.13 as second, developers are using their political powers to make their construction without compliance with the development control, and the planning authorities are scared to stop them or to enforce the development control measure to them as they will removed them or change them from their position. Corruption from Regulatory Bodies with mean score of 3.92 as third reasons, due to the corruption of most of the planning authorities in the study area developers used to carrying out their development best to their needs, as they will give the planning authorities whose has a responsibility of ensuring proper compliance a little amount of money as

bribe to make their construction whether it complied or not. Next is Lack of Regulation Flexibility as fourth with mean score of 3.84, most of the respondents are seeing development control regulation as very complex which will prevent them from during their construction to satisfy their needs despite that the land and construction materials are belongs to them without providing or getting any support from the government that is why they are not compliance. Properties Owners Ignorance, and Lack of Awareness are fifth and sixth reasons for noncompliance with the 3.41 and 2.78 mean score in the study area. Developers are ignoring to comply simply because they are not fully aware or they are seeing it unnecessary in the study area.

## 5.0 CONCLUSION

The paper is based on the assessment of the compliance of development control in Zuru town, with the emphasis on the developer's compliance, the main reason of written this paper is to know whether the migrant to Zuru towns from neighbouring local government within and outside the Kebbi state due to banditry and insecurity that force them to leave their villages and town to start a fresh lives in Zuru which resulted the urban expansion and rapidly development whether they are aware of the development control and to know their extent in compliance with it. The findings of the paper revealed that 63% of the respondent are aware of the development control in the study area, where only 37% respondent are not aware, also out of 100% of the respondents 62% are willing to comply with all the development control measures. It also found out that Room size, building height, and plot coverage has the least compliance in the study area. Various factors that include Plot Coverage, Development Permit (Planning Approval), Set Back Between Buildings and Road, Utilities Availabilities, Land Uses, Building Height, Room Size, and Construction Materials Ventilation Adequacy were used to access the respondents level of compliance in the study area. Compliance on the provision of ventilation adequacy has the highest due to peoples need in bringing in fresh outdoor air and removes the contaminated indoor. Factors that explained the reasons for noncompliance are Human Resources Capacity, Properties Owners Ignorance, Lack of Regulation Flexibility, Corruption from Regulatory Bodies, Political Interference, and Lack of Awareness. The study recommended that there is need for Kebbi State government to provide a document which will serve as planning regulation instruments to use by the planning administration in the state as guidelines for the control of development in the state, as since the creation of the state are still using the Nigerian Urban and regional Planning Law Decree No.88 of 1992 so as to ease the compliance of it by the indigenous developers, as other state that include Lagos, Edo, Oyo among others come up with up-to-date and flexible regulations in their state, consideration of socioeconomic status in the provisions of the regulation is very important for easy compliance by both the low income, medium and high income in the state. Planning authority in the state need to be well equipped with all needed facilities within the state for proper implementation of the development control in the state not only equipped there is also need for good offices which will help them in executing as most of the planning authorities in the state including the study area are living in dilapidated temporary areas as offices without having a conducive and healthier offices, and there is need for planning authorities in the state to create forum which will help them in enlighten their selves on the planning regulations so as to make their selves up-to-date on any development control matters in the state. Also, villages, and towns need to be prepared up-to-date land use plan and strategic plans by the government to effectively guide their growth and the development. Finally public enlighten also need to be organised from time to time to make the citizens aware on any matters regarding development control.

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# Long-term Stock Performance of Private Placement in China-Listed Property Companies

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## ABSTRACT

In alignment with prior research, the present study, focusing on private placement events spanning from 2006 to July 2023 within the Chinese real estate sector, corroborates the prevailing trend of negative long-term returns among companies in this domain. Remarkably, companies achieving successful trade execution concurrently exhibit more favorable long-term performance compared to their counterparts who do not. Furthermore, our analysis reveals the substantial influence of Tobin's Q and leverage on long-term excess returns, with a particularly pronounced effect observed within the realm of private firms.

*Keywords: Private placement, China Listed-property firm, Negative Long-Term Abnormal Return, Ownership*

## INTRODUCTION

Private placements serve as a significant avenue for publicly listed firms to secure vital funds for refinancing purposes. Following their initial public offering (IPO), corporations can raise additional capital by offering additional shares to a select group of sophisticated investors. The attractiveness of this method lies in its low information dissemination costs, primarily due to the limited target audience, making it a preferred choice for listed firms. However, existing research in this domain has predominantly focused on market-wide implications, with limited studies examining the long-term effects of private placements. This paper intends to commence its investigation by examining the real estate sector in China, shedding light on the extended performance outcomes of private placements within specific industries.

One prevalent notion posits that the long-term performance of stocks differs markedly from their short-term reactions during the announcement period, which tend to elicit favorable responses. As indicated by Hertzel, Lemmon, Linck, and Rees (2002), the mean values for the first and second years following a private placement event are -0.107 and -0.086, respectively. These findings align with numerous other studies, such as those conducted by Barclay et al. (1993), Krishnamurthy Krishnamurthy et al. (2005)

in the US, and Baek et al. (2006) in Korea and Jun et al. (2016) in China.

The divergence of stock movements intrigues the curiosities. Regarding the phenomenon of private placements, prominent theories encompass Wurck Wruck (1989)'s Monitoring Hypothesis, Hertzel and Smith (1993) 's Certification Hypothesis, as well as perspectives stemming from the lens of managerial conflicts, including the Tunneling and Entrenchment Hypotheses (Barclay et al., 2007). Lastly, Marciukaityte et al. (2005) et al. propose the Over-Optimism Hypothesis.

Habib and Bruce argue that private placement could be used to provide information. They indicate that the externals not only ease the gap of information, but also the real estate corporation itself needs comments from those skilled investors on the planned project Habib and Bruce Johnsen (2000). Brophy and Ouimet exhibit that institutional investors, particularly hedge funds, are more likely to participate in private placements Brophy et al. (2009). Introducing hedge funds to participate in the private placement of a real estate company with significant risks on an ongoing project may give more steady and valuable cash reserves.

## Data and Methodology

The study sample for this paper is A-share real estate businesses that implemented the private placement between January 1, 2006, and July, 2023. The event data is mostly sourced from the China Stock Market & Accounting Research Database (CSMAR) and the TongHaShun Finance Database. We excluded the following samples: samples related to ST and PT; samples conflicting with other SEOs; and, in cases where multiple events occurred on the same day, only one instance was retained. In the end, we obtained a total of 201 samples, comprising 108 samples where transactions were successfully executed and 82 samples representing failed transactions.

Table 1 presents the statistics of the sample. For example, the average market value of a company is $5.996 billion. At the same time, companies have high leverage, with an average of 65.08%. In addition, the average ROE of the company is 6.8%. It is worth noting that the equity concentration of China's real estate is high, for example, the largest shareholder holds 38.62% of the equity on average, implictily that the large blockholder are less concern of lossing control right via private placements.

Simultaneously, we employed a market model to calculate the expected returns and subsequently computed the excess returns.

$$R_{jt} = \alpha_j + \beta_j R_{mt} + \varepsilon_{jt} \qquad (1)$$
$$AR_{jt} = R_{jt} - (\alpha_j + \beta_j R_{mt}) \qquad (2)$$
$$CAR_j^T = \sum_{t=1}^{T} AR_{jt} \qquad (3)$$

| | | |
|---|---|---|
| $t$ | = | Day measured relative to the event |
| $R_{jt}$ | = | Return on company $j$ on date $t$ |
| $R_{mt}$ | = | Daily return of the Shanghai Real Estate Industry Index (a proxy for the market portfolio of risky assets) |
| $\alpha_j$ | = | Estimated period intercept of firm $j$ |
| $\beta_j$ | = | OLS estimates of company $j$'s market model parameters |
| $R_{mt}$ | = | Daily return of the Shanghai Real Estate Industry Index (a proxy for the market portfolio of risky assets) |
| $AR_{jt}$ | = | The abnormal return of company $j$ on date $t$ |
| $CAR_j^T$ | = | The cumulative abnormal return (CAR) of the company $j$ for $T$ |
| $\varepsilon_{jt}$ | = | The error term of company $j$ on the sample event day $t$ |

We used eq (4) to explore the factors which influecen the long term CAR of proerty firms. Table 2 demostrates the variables that will be used for further regressions.

$$CAR_j^T = \alpha + \beta_1 ROE_j + \beta_2 Leverage_j$$

$$+\beta_3 Tobin_{Q_j} + \beta_4 SOE_j + \beta_5 POE_j$$
$$+\beta_6 Fim\_size_j + \varepsilon \qquad (4)$$

## MAIN RESULTS

Table 3 shows the excess returns for different time Windows. It can be seen that in different time periods, the average return is negative. It can be seen that the CAR in the period (10,250), i.e one year, is -3.97%, which is consistent with the findings of Hertzel et al. (2002) in the United States and Kato Kato and Schallheim (1993) find in Japan . The outcomes of testing with other Chinese academicians on the market are also similar Jianxin et al. (2011) Jun et al. (2016). Another noteworthy trend is that post-event firms are averaging lower CAR over time. In particular, the excess returns are -48.53% percent and -110.98%, respectively, and are statistically significant at the time intervals of two and three and a half years. Panel B shows a similar phenomenon.

We also find that the returns of those companies that successfully implement private placements are generally higher than those of the failed sample, which shown in Panel C and Panel D. Due to space limitations, this paper does not present the full results of these two groups of CARs.

Table 4 shows how each influencing aspect affects the long-term stock price performance of publicly traded real estate companies. The firm's leverage and Tobin-Q values have a positve and statistically significant impact on the firm's long-term cumulative return in all samples. A 1% incrument in leverage, for example, enhances cumulative abnormal returns by around 0.8%. This suggests real estate firms with lower debt ratios have higher cumulative returns, showing that such firms run more effectively rather than increasing debt ratios to achieve higher profit margins.

**Table 1** Descriptive Statistic

| Variable | N | Mean | Median | SD | Max | Min |
|---|---|---|---|---|---|---|
| MV | 201 | 59.9638 | 19.4712 | 152.8491 | 1360.665 | 1.1759 |
| LEV | 201 | 0.6508 | 0.6825 | 0.1895 | 0.9396 | 0.0876 |
| ROE | 201 | 0.0679 | 0.0757 | 0.1292 | 0.3634 | -0.6567 |
| TOP1 | 201 | 38.6246 | 38.6200 | 16.3680 | 82.6100 | 7.1200 |
| SIZE1 | 201 | 23.4111 | 23.3766 | 1.6857 | 28.0157 | 18.524 |

**Table 2** Definition of Variables

| Variable | Proxy | Definition |
|---|---|---|
| Profitability | ROE | Return On Equity. Calculated As: Net Profit/ Average Balance of Shareholders' Equity, Where the Denominator is Calculated as Average Balance of Shareholders' Equity = (Ending Balance of Shareholders' Equity + Beginning Balance of Shareholders' Equity) /2 |
| Capital Structure | Leverage | Debt Ratio, Calculated as Total Debt/Total Asset |
| Relative Value | Tobin_Q | The ratio of Tobin Q. Calculated as Market Value / (Total Assets - Net Intangible Assets - Net Goodwill) |
| Ownership | SOE | Dummy variable, if the company is a state-owned company, the SOE is equal to 1. |
| | POE | Dummy variable, if the company is private-owned, the POE is equal to 1. |
| Firm Size | Fim_size | Market Value of The Firm (Billions of Yuan) |

**Table 3** CAR for Various Time Intervals

| Panel A: Long-term ACAR from +10 days | | | | | | | |
|---|---|---|---|---|---|---|---|
| Variable | N | Mean | p-value | Median | SD | Max | Min |
| [10,50] | 108 | -0.0397 | 0.1370 | -0.0284 | 0.3987 | 0.6232 | -5.3537 |
| [10,150] | 110 | -0.1056 | 0.1850 | -0.0148 | 1.1395 | 1.0027 | -15.4545 |
| [10,200] | 110 | -0.1650 | 0.1297 | -0.0651 | 1.5416 | 1.4114 | -20.8649 |
| [10,250] | 108 | -0.2132 | 0.1133 | -0.0281 | 1.9007 | 1.4658 | -25.7863 |
| [10,500] | 108 | -0.4853* | 0.0797 | -0.1261 | 3.8872 | 3.5126 | -52.8031 |
| [10,900] | 106 | -1.1098** | 0.0341 | -0.4451 | 7.1283 | 4.5006 | -94.931 |
| Panel B: One-year Interval | | | | | | | |
| Variable | N | Mean | p-value | Median | SD | Max | Min |
| [0,250] | 108 | -0.1611 | 0.2526 | 0.0278 | 1.9905 | 1.9365 | -26.7427 |
| [1,250] | 108 | -0.1898 | 0.1750 | 0.0263 | 1.9772 | 1.8738 | -26.6169 |
| [3,250] | 108 | -0.1942 | 0.1596 | 0.0006 | 1.9509 | 1.8163 | -26.3647 |
| [5,500] | 108 | -0.4714* | 0.0911 | -0.0935 | 3.9162 | 3.7653 | -53.161 |
| [3,750] | 107 | -0.8171** | 0.0554 | -0.2122 | 5.904 | 4.4965 | -79.5014 |
| [5,900] | 106 | -1.0953** | 0.0372 | -0.4206 | 7.1562 | 4.7533 | -95.2889 |
| Panel C: CARS for Implemented Samples | | | | | | | |
| Variable | N | Mean | p-value | Median | SD | Max | Min |
| [10,200] | 110 | 0.0306 | 0.4278 | 0.0578 | 0.4030 | 1.0027 | -1.5132 |
| [10,250] | 108 | 0.0300 | 0.5413 | 0.0592 | 0.5081 | 1.4114 | -1.9994 |
| Panel D: CARS for Halted Samples | | | | | | | |
| Variable | N | Mean | p-value | Median | SD | Max | Min |
| [10,200] | 82 | -0.4462* | 0.0860 | -0.2039 | 2.3247 | 1.1166 | -20.8649 |
| [10,250] | 82 | -0.5216 | 0.1042 | -0.1869 | 2.8742 | 1.0053 | -25.7863 |

**Table 4** Regression Results

| CAR[10,250]:Implemented | ALL | | Private | State-Owned |
|---|---|---|---|---|
| ROE | -0.331 | -0.393 | -1.969 | 0.617 |
| | (-0.402) | (-0.488) | (-1.548) | -0.487 |
| Leverage | 0.891* | 0.873* | 1.664** | 0.366 |
| | -1.962 | -1.937 | -2.426 | -0.508 |
| Tobin-Q | 0.197* | 0.184* | 0.275** | -0.075 |
| | -1.975 | -1.889 | -2.452 | (-0.268) |
| Size | -0.053 | -0.048 | -0.163* | 0.06 |
| | (-0.888) | (-0.824) | (-2.007) | -0.545 |
| SOE | -0.099 | | | |
| | (-0.478) | | | |
| POE | -0.158 | | | |
| | (-0.783) | | | |
| Intercept | 0.543 | 0.355 | 2.556 | -1.592 |
| | -0.397 | -0.269 | -1.402 | (-0.645) |
| N | 108 | 108 | 56 | 41 |
| $R^2$ | 0.055 | 0.049 | 0.175 | 0.046 |
| Adj_$R^2$ | -0.001 | 0.012 | 0.11 | -0.06 |
| F | 0.98 | 1.317 | 2.7 | 0.431 |

Tobin-Q has a detrimental impact on long-term cumulative abnormal returns as well. This is similar to the findings of Barclay and Holderness in the United States, which discovered that the relative market valuation is inversely connected to whether a firm uses private placement (Barclay et al., 2007). Our findings suggest that the higher the market valuation of real estate, the better the long-term success of private placement. This conclusion supports the certification hypothesis, which states that the market may believe the private placement transaction convey the signal that the firm is high quality. It is worth noting that there are variances in leverage and Tobin-Q in terms of long-term CAR between firms with the nature of ownership. Private firms have a higher influence coefficient than state-owned enterprises, and both figures are statistically significant. State-owned firms, on the other hand, are insignificant in Tobin-Q and leverage. This distinction may stem from that SOEs have inferior managerial skills, and their nature as SOEs will reduce the pressures from the debt as a hard constraint. At the same time, they have more financial channels (such as banks) and options than private firms.

Table 4 further reveals that in the entire sample, ROE is adversely connected with long-run anomalous returns. Despite the insignificant results, private sector ROE is positively connected with long-run anomalous returns, which is consistent with Ding and Gao (2013) 's what they find in the Chinese market. However, the effect of private and state-owned firms on firm size is opposed. Our research results do not alter when different event study intervals are selected.

## CONCLUSION

Based on an empirical analysis of private placement events in China spanning from 2006 to July 2023, this study discerns a prevailing trend among publicly listed companies within the real estate sector, characterized by negative long-term stock returns. However, it is noteworthy that those companies successfully executing these private placements tend to exhibit superior long-term performance compared to those that do not. Furthermore, our findings indicate that factors such as Tobin's Q and leverage exert a substantial positive influence on the post-event long-term stock price performance. Importantly, this influence is more pronounced among private real estate firms as opposed to state-owned counterparts.

For future research avenues, it is advisable to delve deeper into the examination of long-term price performance across distinct time periods. Additionally, further exploration of factors that may influence long-term returns warrants investigation.

## ACKNOWLEDGEMENT

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# A Review for an Integrated Approach for Policy Implementation of Affordable Public Housing in Ghana

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## ABSTRACT

The housing crisis in Ghana has led various governments to implement numerous interventions and programmes. However, it appears that only a small proportion of needy individuals have been able to benefit from these initiatives. This suggests that the programmes have not adequately addressed the housing needs of a significant portion of low and middle-income households. This assertion is grounded in the observation that the formal procedure utilized in the implementation of affordable housing policies has not been optimal. The objective of this study is to conduct a review of literature and suggest a framework to enhance the current policy implementation process with the goal of facilitating the provision of cost-effective housing options to the populace of Ghana. This study employed a comprehensive search of both published and unpublished documents to gather relevant information for the research. The paper's findings indicate that the policy implementation process for affordable housing in the country has consistently relied on a top-down approach. This approach, however, may have a discouraging effect on the participation of the targeted households in the policy-making process, ultimately leading to programme failure or a lack of benefit for the intended beneficiaries. It is noteworthy that the involvement and perspectives of these households are pivotal for the effective execution of policy implementation. It is therefore recommended that an integrated approach, encompassing both top-down and bottom-up approaches, be considered as a viable solution to tackle the issue of affordable housing in Ghana. The proposed approach entails a decentralized and participatory implementation of affordable housing policy, wherein both the government and the intended households are involved in sharing their perspectives and requirements. This collaborative effort will facilitate the achievement of the policy's objective of providing affordable housing. The paper presents a conceptual framework for policy implementation process for a successful affordable housing policy.

*Keywords: Affordable Housing, Integrated Approach, Policy Implementation, Households, Ghana.*

## INTRODUCTION

Access to affordable housing has become problematic for low and middle income households (Lum and Zhou, 2019). For this reason, development of housing policies to address the affordable housing situation have been on various governments' agendas in recent years (Leishman and Rowley, 2012). Unfortunately, many governments in their quest to develop affordable housing policies have neglected the important role of the beneficiaries' in the process (Ramovha and Thwala, 2012). In Sub-Saharan Africa in which Ghana is a member, many public housing policies have been developed over the years to help address the housing needs of the low- and middle-income households. Nonetheless, these efforts have been proved inept of meeting the housing needs of the increasing urban population. Apparently, only a small section of the population, parting most of the low-income households to live in dilapidated homes (Arku, 2009). The fact is that, the people who designed the policies do not know or understand the special needs of the beneficiaries; hence leading to housing that does not meet the real needs of the intended beneficiaries (de Pacheco Melo, 2017). Clearly, success of housing programmes depends not only on the supply of housing, but also the inputs of the intended beneficiaries that should be considered in the housing development process (Aigbavboa and Thwala, 2018).

## MAIN RESULTS

The study reviewed about 30 articles in about 25 academic journals from 2000 to December 2020. The findings from the reviewed literature indicates that, most housing policies have inherently used a top-down approach (Jaiyeoba and Asojo, 2020). The top-down approach is based on the discretion of the State and the other associated bodies who decides upon the matters without the involvement of the beneficiaries (Bardhan et al., 2015). This in effect makes the developed programme to have a hierarchical structure in which the beneficiaries are unable to influence the policies based on their needs (Roitman, 2016). Although, Singapore is best known as a successful case of top-down initiatives. The bottom line of Singapore public housing development is verticalization of space to fully utilize limited land. In addition, it has several characteristics that set it apart from its competitors and contribute to its success (Chee, 2017). But same cannot be said in developing countries like Africa and for that matter, Ghana. Because, this approach has been a major reason why many projects have not been effective in the past in achieving their objectives. It has failed to meet the needs of the beneficiaries and moreover had an impact on the overall performance of affordable housing projects (Adeogun and Taiwo, 2011). Since colonial times, the government of Ghana has taken several policy steps to aid the housing market (Boamah, 2014). The gap between plans and actual implementation has been large, however, in both rural and urban settings (UN-Habitat, 2010). Addo (2014) gave a simple reason to the failure of these several housing policies and programmes. She indicated that, governments' housing policies over the years have practically not been based on the needs assessment of the intended beneficiaries. Moreover, beneficiaries have no say in their making. Therefore, the implementation of these top-down policies normally ends up benefiting the upper classes rather than the originally intended low- and middle-income urban employees (Bangdome-Dery et al., 2014).

Importantly, the weakness of the top-down approach called for numerous studies to advocate for a bottom-up approach, which involves the beneficiaries in decision-making (Bardhan, 2015; Pissourios, 2014; Muraya, 2006). This approach was acknowledged to promote enabling strategies in an effort to overcome obstacles encountered under the top-down approach. The argument made by Nguyen (2019) is that, the bottom-up approach pays more attention to the policy actors participating in the implementation

and their strategies to pursue their objectives rather than the policy itself. For instance, Liu and Ravenscroft (2017) indicate that, when beneficiaries are empowered to participate in the policy process, there is a possibility to reach a broader consensus on the best approach to address the problems, while protecting and monitoring beneficiaries' interests. Similarly, demands for more participation in decision-making, account for more accountability on the part of local politicians and officials and increasing criticism of technical expertise (Murray et al., 2009). The major distinction between top-down and bottom-up approaches appears is the level of user or beneficiary participation in policymaking and implementation (Yi et al., 2020). Ironically, the adoption of only bottom-up approach for affordable public housing policy implementation was also criticized for its sub-optimal policies, delays the project, and often deflects centrally mandated programmes toward its own purposes (El Asmar, 2012).

Therefore, drawing from the different studies and each approach shortcomings, this current study calls for an integrated approach. Murray et al. (2009) emphasized that responsive public decision-making involves the building of bridges between these two camps. Thus, the benefits of top-down and bottom-up perspectives and real descriptions called out for common ground between them (Chand, 2011). Research has shown that combining the two methods into a single strategy yields better policy results. For instance, in post-disaster housing reconstruction (Yi et al., 2020), land transfer policy (Liu and Ravenscroft, 2017), urban and regional planning (Pissourios, 2014), urban redevelopment policy (El Asmar, 2012), and urban village redevelopment modes (Yang et al., 2020). All these policies were implemented to improve the lives of low-income households. Therefore, looking at Ghana situation and the country's political nature, the integrated approach can be adopted to help address its affordable housing challenges. Even though, certain conditions and factors differ in terms of socio-cultural and political differences from these countries, the study believes that it can be modified to fit into the Ghanaian context. Therefore, the research framework shown in figure 1 below is being proposed for this study. The intention of the framework is to help address the gap in the literature based on involvement of beneficiaries for effective policy implementation for affordable housing to the Ghanaian public.
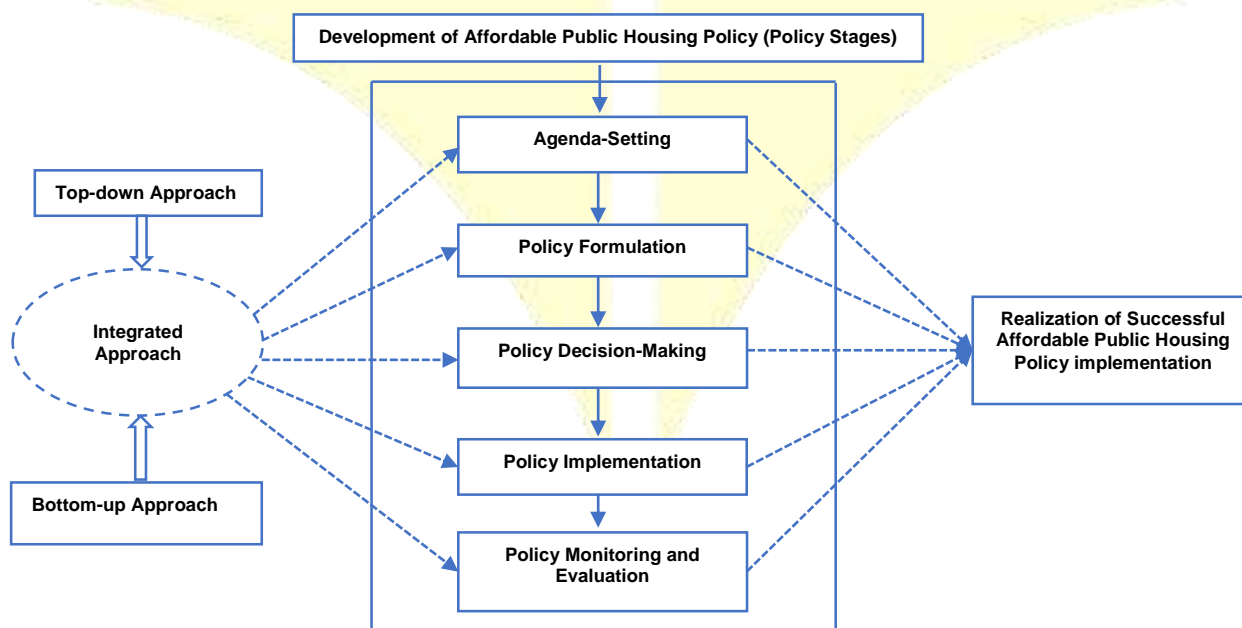


**Figure 1** Proposed Integrated Approach Framework (Adapted from Howlett (2019) and Modified by Authors)

The policy stages as indicated in the framework were advanced by Howlett (2019) as a process for public policy development. These stages have been briefly elaborated below:

i.  Agenda-Setting Stage: This is the stage where the problem recognized is actually put on the agenda for serious consideration of public action (Fischer and Miller, 2017). This stage is seen to be the most important part of the policy process since it decides on the issue to be addressed during the decision-making stage (Princen, 2007). The inclusion of beneficiaries in the agenda-setting process is widely recognized as crucial to its ultimate success. Abma and Broerse (2010) argued that, depending on the make-up of the participants, beneficiaries' involvement can result in substantial enrichment of agenda-setting.

ii. Policy Formulation Stage: This refers to the stage where policy options are explored by stakeholders and then reduced to some set which are relevant and useful in providing possible solutions to the affordable housing problem (Howlett, 2019). It is worthy to note that, the interaction between the government and beneficiaries is the most important aspect that might affect the policy formulation of the policy (Savard and Banville, 2012). In this case, understanding the needs of the beneficiaries during this stage is crucial (Turnpenny et al., 2015).

iii. Policy Decision-Making Stage: This is the stage where stakeholders adopt a particular course of action or non-action to address the problem. Nguyen (2017) argued that, in genuine and complex decision-making situations, decision makers may run the danger of making an incorrect estimate and may be hampered by a lack of time and information. This demonstrates the need of establishing effective coordination between government actors and beneficiaries that are expected to reap the policy's benefits. In addition, this concerted public effort will allow stakeholders to weigh the pros and cons of several options before making a call (UNDP China, 2017).

iv. Policy Implementation Stage: This relates to how stakeholders adopt course of action on affordable housing and put into effect. Because this concerns the means through which governments put policies into practice, policy implementation is regarded as a crucial phase of the policy process (Howlett, 2019). A policy's players, especially the public officials who are charged with responsibility for its implementation, are established to be a major contributor to the gap between the policy's goal and its outcome. For this reason, a call has been made for beneficiaries to be involved in this stage since the outcome will directly have impact on them. Therefore, their views and decisions on how to implement the policy is paramount (Savard and Banville, 2012).

v.  Policy Monitoring and Evaluation mechanisms are essential for effective policy implementation (United Nations, 2017). The implementation concerns beneficiary's satisfaction with the outcome of the project and how well the programme has met its goals (Johnson and Iweka, 2019). For this reason, Fischer and Miller (2017) indicate that, results of the implementation must be evaluated against the objectives and adjusted if needed. To this end, the intended beneficiary's involvement in monitoring and evaluation is to help better define and implement the interventions under consideration. Government and intended beneficiaries are both called to assess how the affordable housing is effectively implemented and whether there are

gaps between the planned and achieved results.

## CONCLUSION

The developed framework is based on the premise that, whereas it is good for the government and policy makers to develop affordable housing policies, it is also better to do so based on an understanding of the factors that influence the needs of beneficiaries and their ultimate satisfaction with the affordable housing product. The proposed framework can be used by stakeholders in the housing sector: government, policy makers, developers as well as intended beneficiaries to achieve better affordable housing implementation. In so doing, the affordable housing which boils down to income and affordability will be addressed. Therefore, in future, the proposed framework will be validated through focus group discussions to streamline the framework with specific scope that will be significant to all stakeholders.

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# HARVESTING HIGH-RISES: A COMPREHENSIVE ANALYSIS OF URBAN FARMING PRACTICE AND ISSUES

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## ABSTRACT

The increasing number of buildings that have embraced urban farming is evidence that it has begun to gain popularity in Malaysian cities. The increasing number of buildings that have adopted urban farming practices reflects the growing acceptance of this trend in Malaysian society. They began to put this into practise because it has contributed to the growth of a variety of environmental, economic, and social benefits for the surrounding communities. However, it should be highlighted, that this tendency has the potential to harm and deteriorate building structures without proper management. Therefore, the aim of this study is to perform a comprehensive review of the urban farming issues that arise due to inefficient management teams. To achieve this aim, papers published from years from 2011 to 2023 are searched on various platforms. The result of this search identified seventeen articles suitable for review. The findings indicate that urban farming may have negative effects on buildings and occupants, but these issues can be minimised through identification that has been made in this study. Hence, further research is required to gain a better comprehension of the correlation between urban farming and building management. This research can result in the formulation of efficient implementation tactics that can alleviate the consequences of climate change in urban regions.

*Keywords : urban farming, issues urban farming, impact of urban farming*

## INTRODUCTION

In recent years, rapid urbanisation has led to significant changes in landscapes across most countries, transforming once green areas into concrete forests and causing a substantial reduction in natural spaces (Shafique et al., 2018). Startling statistics by the Food and Agriculture Organisation of the United Nations show that nature's footprint has diminished considerably, with an alarming decline in forests, wetlands, and green belts as the area of primary forest worldwide has decreased by over 80 million hectares since 1990 (FAO & UNEP, 2020). As a consequence, cities have experienced the emergence of urban heat islands and various environmental challenges, prompting a shift towards a sustainable and greener approach. The decline of nature areas due to rapid urban development and climate change related issues has sparked a global interest in

urban farming to counterbalance the environmental impact and bring back nature's touch within the city confines (Czemiel Berndtsson, 2010; Fioretti et al., 2010; Joshi & Teller, 2021; Shafique et al., 2018). Implementing urban farming as means of nurturing green spaces within cities is a sustainable solution to address environmental challenges such as the urban heat island effect, promote eco-friendly practices, and align with the broader goals of the SDGs (Joshi & Teller, 2021).

According to Sam & Hui (2011), urban farming, as a practice, involves cultivating plants and crops within urban settings, be it on rooftops, balconies, or vacant spaces. Al-Kodmany (2018) and Astee & Kishnani (2010) added that this approach not only enhances food security and reduces food miles but also aligns with the Sustainable Development Goals (SDGs) of creating sustainable cities and promoting responsible consumption. Chaminuka & Dube (2017) stressed that, when more urban dwellers embrace urban farming, it contributes to localising food production, which can constitute food security, and fostering a stronger sense of community and self-sufficiency. In addition, one of the significant advantages of urban farming is its potential to mitigate the urban heat island effect (Hui, 2006; Joshi & Teller, 2021; Sam & Hui, 2011). The vast expanses of concrete and asphalt in cities absorb and retain heat, leading to higher temperatures within urban areas compared to their surrounding rural regions. By introducing green spaces through urban farming, more vegetated surfaces can be created that can absorb heat, release moisture, and bring down temperatures (Gagliano et al., 2016), making cities more livable and ecologically balanced.

However, the successful implementation of urban farming within high-rise buildings necessitates careful consideration and proper management. Without adequate planning and maintenance, the weight of soil and vegetation can strain the building's structure, potentially leading to

deteriorating conditions and safety concerns (Whittinghill & Starry, 2016). Hence, a cautious approach is necessary when implementing high-rise urban farming to prevent potential damage to buildings, ensuring that this progressive movement remains a positive force in shaping the cities for a greener and more sustainable future. To ensure the enduring sustainability of urban farming, effective management is essential. This involves proactive attention from dedicated teams to identify and address common challenges inherent in this practice, which can impact the overall building conditions. These challenges are systematically categorised into four key elements: management, technical aspects, human resources, and financial considerations. This classification has been devised to streamline the subsequent phase, which aims to assist management teams in identifying solutions to address individual issues as they arise.

Therefore, the aim of this paper is to perform a comprehensive review of the issues of urban farming that arise due to inefficient management teams. The objective of the research is to identify the issues that arise in the high-rise urban farming practice. To accomplish the intended objective, the paper presents its findings, which serve to augment the existing body of knowledge which currently places greater emphasis on aspects such as benefits, design and impact. The organisation of this paper unfolds as follows: The second section expounds upon the employed methodology for this paper. The third section furnishes the results of comprehensive literature review of existing literature pertaining to urban farming issues. A discussion of the resultant outcomes follows in the fourth section. The final section encapsulates the study's conclusions.

## METHODOLOGY

This study aimed to provide a comprehensive understanding on how the issues of urban farming affects building

conditions and occupants. To achieve this goal, the most up-to-date information within 10 years was available, articles and journals published between 2013 and 2023 were prioritized and a review of the literature on issues on urban farming in high-rise buildings was conducted. The review included articles and journals from leading publishers, as well as conference proceedings were obtained from Scopus, Web of Science (WOS), ProQuest, Research Gate, Google Scholar and others platform. By using following search terms: 'urban farming', 'urban farming issues/challenges/impact', and 'urban farming maintenance', 'building maintenance', a search on Google Scholar's multi-database and cross-disciplinary online citation services are conducted as a process of reviewing the literature. The papers were selected and reviewed to identify the issues of the urban farming at high-rise residential buildings in the context of the current situation and the existing literature.

Hence, it is necessary to draft clear and concise Research Questions (RQ) which drive the entire review methodology. As the objectives of this article are; to analyses the issues of urban farming affects building conditions and occupants, the research questions addressed by this study are as follows:

RQ   : What is the research evidence indicating the existence of issues of urban farming that affected building condition and the occupants?

  **To address RQ, the number of documents published will be analyzed.

As a result, about seventeen research papers were selected as it seems to be relevant to the topic of issues of urban farming. Hence, the structure of this paper is started with The Introduction, and Urban Farming Practice in Malaysia, to provide the necessary conceptual understanding for the reader about the study. Next will be focused on the Issues of Urban Farming which will strengthened by the results as well as the recommendations for the

directions of future research.

## RESULTS

*Introduction of Urban Farming*
Urban farming has gained significant recognition worldwide due to its myriad benefits to communities. According to Salim et al. (2019) urban farming, also known as urban agriculture, is the practice of growing food in urban areas. It can be used to connect food production with the built environment of the city, providing fresh food for residents and helping to improve the overall health of the city. Fresh, local food supplied to urban communities, can help create a more sustainable and resilient food supply chain (Grebitus, et al. ,2020). Additionally, the direct link between food production and consumption can help promote healthier eating habits among urban dwellers. The motivations and drivers for urban farming vary, but they are all shaped by the need to address the challenges of urbanisation. As Orsini et al., (2014) stated, these challenges include the loss of fertile land, deforestation, air and water pollution, and the creation of peri-urban areas where poverty is concentrated. Urban farming can help address these challenges by providing fresh food, reducing pollution, and improving the quality of life in cities.

*Urban Farming Practice in Malaysia*
Urban farming is a diverse practice that encompasses a variety of techniques tailored to the unique constraints and opportunities of urban environments. A study by Thomaier et al. (2015) identified four prominent types of urban farming: vertical farming, open rooftop farms, rooftop greenhouses, and productive facades. Vertical farming is the practice of growing crops in vertically stacked layers, such as on rooftops or in multi-story buildings. Open rooftop farms are simply farms that are located on rooftops. Rooftop greenhouses are similar to open rooftop farms, but they use greenhouses to protect crops from the elements. Productive facades are walls or other vertical surfaces that are used to grow plants. Rooftop farming is another type of urban farming

that can help address the challenges of space constraints and environmental pollution. As Harada & Whitlow (2020) noted, rooftop farming can be a sustainable solution for urban agriculture, as it utilises otherwise underutilised space in the built environment. Rooftop farms can grow a wide variety of crops, from leafy greens to herbs and even small fruit trees, without taking up valuable ground space in crowded urban areas. This type of farming can also help improve air quality and reduce the urban heat island effect.

The popularity of implementing green roofs in Malaysia's urban areas is on the rise, driven by the numerous benefits they offer. This trend is noteworthy, even Malaysia is on the brink of venturing into the realm of urban farming. Although Malaysia is in the earlier phases compared to other developed countries, the progress is steadily advancing, showcasing a more modest but promising approach to urban farming practices. Table 1 shows several significant urban farming practices in high rise buildings in Malaysia.

**Table 1:** List of Malaysian Greenery Buildings
(Adapted from Izzah et al., 2013; Pei Jun, 2018; Sengodan, 2022; Zahir et al., 2014)

| Buildings | Type of Buildings | Type of UF |
|---|---|---|
| Rice Garden Museum, Langkawi | Public | Intensive green roof |
| Ministry of Finance, Putrajaya | Office | Intensive green roof |
| Putrajaya International Convention Centre | Public | Intensive and Extensive green roof |
| Putrajaya City Hall, Putrajaya | Public | Extensive green roof |
| Putrajaya Government Administration Centre | Office | Edible Garden and Community Gardens' |
| Malaysian Design Technology Centre, LKW, Cyberjaya | Institutional | Extensive green roof |
| Serdang Hospital | Hospital | Intensive green roof |
| Faculty of Social Sciences and Humanities, UKM | Institutional | Retrofit Extensive green roof |
| Sime Darby Oasis, Damansara | Office | Extensive green roof |
| KL Sentral Park @ Platinum | Office | Intensive green roof |
| Newcastle University Medicine Malaysia, Nusajaya | Institutional | Extensive green roof |
| Laman PKNS, Shah Alam | Office | Intensive green roof |
| Heriot-Watt University, Putrajaya | Institutional | Extensive green roof |
| Tun Razak Exchange (TRX) | Commercial | Intensive green roof |
| One Utama Shopping Centre | Mall | Rooftop Garden |
| Lot 10 Rooftop, Bukit Bintang | Mall | Rooftop Garden |
| Forest City, Johor | Commercial | Rooftop Garden |
| Jeli Polytechnic Tanah Merah, Kelantan | Institutional | Rooftop Garden |

| | | |
|---|---|---|
| Hotel Bunga Raya, Johor | Hotel | Extensive green roof |
| Central i-City Mall, Shah Alam | Mall | Rooftop Garden |
| Acapella Residence, Shah Alam | Hotel | Intensive green roof |
| The Arc at Bandar Rimbayu, Shah Alam | Commercial | Semi-Intensive green roof |
| Masjid Kota Iskandar, Nusajaya, Johor | Public | Extensive green roof |
| DBKL-KL Heritage Trail | Public | Extensive vertical green walls |
| Platinum Central's, Kuala Lumpur | Office | Extensive vertical green walls |
| G Tower's, Kuala Lumpur | Commercial | Extensive vertical green walls |
| DIGI Technology Operation Centre, Shah Alam | Offices | Extensive vertical green walls |

The significant urban farming that has been practised in Malaysia shows that nowadays design of modern high-rise buildings in urban areas has become increasingly prevalent in the inclusion of greenery elements such as green roof, rooftop garden and vertical green walls. Therefore, with this great development, there is concern this practice has a potential to harm and deteriorate building structures without proper management. Nevertheless, the issues that arise during the implementation of urban farming must be taken into account, to minimise the impact towards building condition and occupants.

*Issues of Urban Farming*
Undoubtedly, urban farming has demonstrated diverse benefits for various stakeholders. From enhancing food security to promoting sustainable practices, its positive impacts are evident. However, it is imperative to highlight the accompanying consequential issues it brings forth. Past studies have delved into the intricate web of issues related to urban farming, aiming to dissect and illuminate

these matters for all involved parties. This paper aims to catalyse proactive measures by conducting a literature analysis to ensure the continued and robust growth of urban farming in Malaysia, ultimately fostering a harmonious balance between its advantages and the hurdles it presents.

A review of the previous studies reveals the most common issues that happened in urban farming practices had identified. Fourteen factors were identified from this review namely, lack of awareness, collaboration, policies, guidelines, and standards, and limited knowledge and local expertise. Additionally, factors such as lack of incentives from the government, inadequate training and skills, limited local research, unknown risk, high cost, leaky roof or seepage, mould and dampness, increase occurrence water pond, as well as impose more loads on building structure, and susceptible to fire have been underscored as critical elements within these practices. All those factors have been summarised in Table 2 below.

**Table 2:** Issues of Urban Farming and Abbreviation and description of the urban farming issues

| | Issues of Urban Farming | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **References** | **Issues** | | | | | | | | | | | | | |
| | LA | LC | LP | LE | LI | ITS | LR | UR | HC | LR/F | MD | IW | IL | SF |
| Sam&Hui, 2011 | | | | | | | | | | | | | 1 | |
| Braithwaite, 2012 | | | | | | | | 1 | 1 | | | | | 1 |
| Zhang et al., 2012 | | | | | | | | 1 | 1 | | | | | 1 |
| Zahir et al., 2014 | | | 1 | 1 | | | | 1 | | 1 | | | 1 | |
| Arizzi et al., 2015 | | | | | | | | | | | 1 | | | |
| Whittinghill & Starry, 2016 | | | | | | | | | | | | | 1 | |
| Ezema et al., 2016 | 1 | | | 1 | 1 | | | | 1 | | | | 1 | |
| Chow & Abu Bakar, 2016 | | | 1 | 1 | | | 1 | 1 | 1 | | | | | 1 |
| W. Z. W. Ismail et al., 2018 | | | | 1 | 1 | | 1 | | 1 | | | | | |
| Shafique et al., 2018 | | 1 | | | | | 1 | | 1 | 1 | | | | |
| Udawattha et al., 2018 | | | | | | | | | | 1 | | 1 | | |
| Mong et al., 2019 | | | 1 | 1 | | 1 | | | 1 | | | | | |
| Drozd, 2019 | | | | | | | | | 1 | 1 | 1 | 1 | 1 | |
| Jha Ritesh Kumar et al., 2019 | | | | 1 | 1 | | | | | 1 | 1 | | 1 | |
| Ismail, 2020 | 1 | 1 | | 1 | | | | | 1 | | | | | |
| Mahdzir et al., 2020 | 1 | | 1 | 1 | 1 | | 1 | 1 | 1 | | | | | 1 |
| Cao et al., 2022 | 1 | | 1 | | | 1 | | | 1 | | | | | |
| **Score** | 4 | 2 | 5 | 8 | 4 | 2 | 4 | 5 | 11 | 5 | 4 | 1 | 6 | 4 |

| Abbreviation | Issues |
|---|---|
| LA | Lack of awareness |
| LC | Lack of collaboration |
| LP | Lack of policies, guidelines, standards |
| LE | Limited knowledge/local expertise |
| LI | Lack of incentive from government |
| ITS | Inadequate training and skills |
| LR | Limited local research |
| UR | Unknown risk |
| HC | High cost |
| LR/F | Leaky roof/floor or seepage |
| MD | Mould/Dampness |
| IW | Increase occurrence water pond |
| IL | Impose more loads on building structure |
| SF | Susceptible to fire |

One of the biggest issues in urban farming is high cost either in construction or maintenance. Approximately eleven out of seventeen researchers have highlighted the issue of costs associated with initial installation and ongoing plant maintenance as a significant challenge, attributing it to the difficulty in procuring supplies stemming from a scarcity of available suppliers (Cao et al., 2022; Chow & Abu Bakar, 2016; Drozd, 2019; Ezema et al., 2016; W. Z. W. Ismail et al., 2018; Z. A. Ismail, 2020; Mahdzir et al., 2020; Mong et al., 2019; Shafique et al., 2018, Braithwaite, 2012; and Zhang et al., 2012). The scarcity of suppliers underscores a broader issue of inadequate exposure and awareness across all stakeholders, leading to diminished demand within the urban farming market. This assertion finds validation in the works of Cao et al. (2022); Z. A. Ismail, (2020); Mahdzir et al. (2020); and Zahir et al. (2014), who have identified this concern as a significant factor in their respective studies.

Closely related with the aforementioned concern is the researchers' emphasis on the lack of local expertise and limited knowledge. A consensus among approximately eight out of seventeen researchers, including Chow & Abu Bakar (2016), Ezema et al. (2016), W. Z. W. Ismail et al. (2018), Z. A. Ismail (2020), Jha Ritesh Kumar et al. (2019), Mahdzir et al. (2020), Mong et al. (2019) and Zahir et al., (2014) underscores the prominence of this issue. This collective insight illustrates that reduced awareness correlates with a lack of expertise, possibly originating from the decreased interest exhibited by individuals in this practice.

Notably, Cao et al. (2022) and Mong et al. (2019) also voice the concern that this deficiency can result in inadequate training and skills among building managers, stemming from their limited experience with urban farming. Such inadequacy in management can lead to subpar maintenance practices. For instance, it can lead to consequences like an increase in structural load, (Drozd, 2019; Ezema et al., 2016, Jha Ritesh Kumar et al., 2019,

Zahir et al., 2014, Sam & Hui, 2011; and Whittinghill & Starry, 2016), along with issues such as roof or floor leakage and seepage, (Drozd, 2019, Jha Ritesh Kumar et al., 2019, Shafique et al., 2018, Zahir et al., 2014, and Udawattha et al., 2018), as well as problems like mould and dampness (Arizzi et al., 2015; Udawattha et al., 2018, Drozd 2019 and Jha Ritesh Kumar et al. 2019). Furthermore, susceptibility to fire, (Chow & Abu Bakar, 2016, Mahdzir et al., 2020, Braithwaite, 2012; and Zhang et al., 2012), as well as an increased occurrence of water ponds, (Drozd, 2019), and vulnerability to unknown risks, (Chow & Abu Bakar, 2016, Mahdzir et al., 2020, Zahir et al., 2014, Braithwaite, 2012; and Zhang et al., 2012), all stem from these underlying deficiencies in expertise and training.

Upon closer examination of the urban farming practice, a pattern emerges where the subsequent challenge revolves around the absence of comprehensive policies, guidelines, and standards. As emphasised by Cao et al. (2022), Chow & Abu Bakar (2016), Mahdzir et al., (2020), Mong et al., (2019) and Zahir et al., (2014), there is a pressing need for government intervention to address these concerns. Establishing a structured framework would provide valuable guidance to building managers, enabling them to effectively oversee urban farming initiatives. Governmental involvement becomes pivotal, not only in facilitating informed management but also in extending incentives to encourage widespread adoption (Ezema et al., 2016, W. Z. W. Ismail et al., 2018, Jha Ritesh Kumar et al., 2019, and Mahdzir et al., 2020), thereby fostering a nurturing environment for further development.

Furthermore, the issue of lack of collaboration surfaces as a significant challenge within this domain. The efficacy of urban farming could be substantially heightened through multi-stakeholder engagement, enabling collective problem-solving and more comprehensive solutions (Z. A. Ismail, 2020; Shafique et al., 2018). In essence, involving diverse perspectives could not only enhance the

practice but also contribute to its overall success by addressing challenges collectively.

## DISCUSSION

Based on the review of previous sections, the literature that discussed the issues of urban farming has found an exploration of the various challenges in urban farming practices reveals a complex web of interconnected issues. The limited number of suppliers, coupled with a lack of exposure and awareness, contributes to diminished demand in the urban farming market. Furthermore, the scarcity of local expertise and limited knowledge hinders the effective implementation and maintenance of urban farming initiatives. Addressing these issues requires a multi-faceted approach, involving the establishment of comprehensive policies, guidelines, and standards, along with governmental incentives to promote widespread adoption. Collaborative efforts from diverse stakeholders are essential to overcome these challenges and pave the way for successful and sustainable urban farming practices. The findings from studies across different regions, including Malaysia, emphasise the universality of these challenges and their potential implications in the context of Malaysian urban farming.

In order to facilitate the subsequent steps aimed at assisting management teams in devising solutions for the identified issues, a classification has been constructed by the author. This classification draws inspiration from the work of Hauashdh et al. (2020) and hinges on the suitability of each issue's aspects and characteristics. Accordingly, the classification reveals distinct categories of challenges. The realm of management issues encompasses a lack of collaboration between stakeholders, as well as deficiencies in awareness and the formulation of policies, guidelines, and standards. On the technical front, maintenance-related concerns come to the forefront, encompassing issues like leaky roofs or seepage, mould and dampness, the increased occurrence of water ponds, additional structural loads, susceptibility to fire, and unforeseen risks. Human resources issues manifest in the form of insufficient local expertise, inadequate training and skills, and limited knowledge and local research. Financial considerations take centre stage as well, involving the absence of incentives from the government and the presence of high initial and maintenance costs.

As a result, the issues within the realm of urban farming have been categorised into four pivotal dimensions: management, technical, human resources, and financial. This structured classification, as delineated in Table 3 below, serves as a valuable foundation for strategising comprehensive solutions to address the multifaceted challenges faced by urban farming endeavours.

**Table 3:** Urban farming issues grouped according to management, technical, human resources, and financial categories

| Category | Issues |
|---|---|
| Management | Lack of collaboration between stakeholders |
| | Lack of awareness |
| | Lack of policies, guidelines and standards |
| Technical | Maintenance issues |
| | • leaky roof or seepage, |
| | • mould and dampness, |
| | • increase occurrence water pond, |
| | • impose more loads on building structure, |
| | • susceptible to fire, and |
| | • unknown risk |
| Human Resources | Lack of local expertise |
| | Inadequate training and skills |
| | Limited knowledge and local research |

| | |
|---|---|
| Financial | Lack of incentive from the government High initial and maintenance cost |

## CONCLUSION

A number of studies have shown that urban farming can provide many benefits, based on research done by Drozd (2019), Hui (2006), W. Z. W. Ismail et al. (2018), Jha Ritesh Kumar et al. (2019), Shafique et al. (2018), and Zaid et al. (2018). Nonetheless, several studies have underscored a range of significant challenges that can impede the progress of urban farming practices. These issues can be classified into four key areas; management, technical, human resources, and financial considerations. A comprehensive grasp of how these issues reverberate through maintenance organisation performance, maintenance service quality, and building performance can direct our focus towards crafting effective strategies. These strategies aim to mitigate the impact of these issues and enhance the urban farming practices in Malaysia. Moreover, guided by four fundamental approaches—namely, effective management, technical prowess, human resources development, and prudent cost optimisation—solutions can be harnessed to alleviate these challenges and their resultant effects. Such measures directly contribute to the augmentation of urban farming practices in Malaysia.

Furthermore, this study shows that the involvement of building stakeholders and delving into future research initiatives is necessary to chart a progressive trajectory for urban farming practices. This collaborative endeavour is imperative to not only pave the way forward but also to ensure the application of effective strategies. The relationship between challenges, their effects, and prospective solutions resonates across organisational dynamics, maintenance services, building performance, and the satisfaction of building users.

Future studies should explore more on the relationship between issues, their effects, and the way forward, and it indicates that issues can affect the organisation, maintenance service, building performance, and satisfaction level of building users. In conclusion, driving the development of urban farming in Malaysia necessitates sustained commitment and concerted efforts from all stakeholders. The imperative lies in conducting in-depth research and launching initiatives that harmonise urban farming with the diverse needs and aspirations of the nation. This holistic approach is poised to unlock a promising future for urban farming while serving as a guidance for forthcoming research endeavours.

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# RESIDENTS' ASSOCIATION CHALLENGES IN GUARDED NEIGHBOURHOOD MANAGEMENT

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## ABSTRACT

According to Maslow's Hierarchy of needs theory, housing is one of the basic human needs. Housing tenure can be categorised into homeownership and renting. Malaysia is considered a "homeownership nation" primarily due to the high homeownership rate of 77% recorded in 2019. However, the homeownership trend in Malaysia, particularly in urban areas, is expected to decline due to rising housing costs. This paper aims to provide an overview of the housing tenure choice among Malaysian. The housing tenure trend in Malaysia and the factors that influence Malaysian's intention to purchase or to rent a house will be discussed in this paper. This paper will provide insights on the housing tenure preferences of Malaysians and assist the government in formulating policies to ensure that all citizens are able to own or rent housing.

*Keywords : Rent, Own, Housing Tenure, Malaysia*

## INTRODUCTION

The rising of gated and guarded neighbourhood under non strata tittle is growing rapidly despite the lack of up to date statistical data provided by the Federal Department of Town and Planning Country Planning. Generally, guarded neighbourhood was formed by developer and residents' association. For new neighbourhood, developer build the housing with safety environment by providing fences, guard house, walls and exclusive amenities. The existing traditional neighbourhood jointly restrict their neighbourhood access by erection of guardhouses and barriers on public roads. Nowadays, safety and security are important for urban living and people want to be assured that they are living safe and secure in their neighbourhood. In Malaysia developers created enclosed neighbourhoods by offering housing with security features such as fences, walls, security control huts whilst for existing housing, residents agreed to take care of their neighbourhood by setting up barriers or placing cones for blocking outsiders to enter the neighbourhood (Tedong et., 2014).

Based on Department of Town and Country Planning (2010), the term in Malaysia applies the guarded neighbourhood as a mutually agreed term. This neighbourhood refers to a residential

complex with individual property status that has security features either by building a guardhouse or not, and whether to set up a fence in the neighbourhood or without a fence. In the overseas, enclosed neighbourhood is a privatize neighbourhood that is also growing in the countries like Africa, America Latin and Asia (Webster, 2002).

Past research has shown that names such as enclosed neighbourhood in South Africa and Nigeria (Oluseyi, 2008), privately governed neighbourhoods in China (Chen and Webster, 2004), guarded housing estate in Lebanon and private neighbourhood in United States of America (Glasze, 2005) are a part of the neighbourhood that have fences or guards in the effort to combat crime and protecting the committees and the surrounding safety.

In ensuring a neighbourhood can be managed more systematically requires one party to govern the neighbourhood. This is known as a residents' association which is a form of management consisting of residents living in the neighbourhood who will be responsible for ensuring that not only the security but the neighbourhood is in a more secure state. Residents' association are consists of parties who voluntary to govern their neighbourhood including their community to ensure their environment become safety and secure. As a very important bodies in community level management, all responsibility related to their neighbourhood is undertaken by residents' association. In the community governance, they more focus on their community and decision making will including community interest (Totikidis et al., 2005).

Reality, the roles of residents' association is the best public relations exercise because of residents' association become a representatives to convince inhabitants to participate in the schemes. As a public community, less information and educational regarding the laws or guidelines give the challenges to them in clear understanding about guarded

neighbourhood concepts. Based on Webster (2002) studies finding that neighbourhood enclosing give the effect to residents' association management. Basically for daily routine, residents' association will monitors and identify any problems in their neighbourhood for instances cleanliness, safety and privacy.

Although there are differences in terms of terminology or understandings of the existing national and foreign society associations, the definitive population association is responsible for matters relating to the administration of common property such as security, sanitation services and any services deemed necessary by Residents' Association (Gibson and Koontz, 1998). Population associations may also consider carrying out activities such meetings to resolve issues arising, family day with residents, crime prevention campaigns and so on (Tedong et al., 2012).

In governing these neighbourhoods, there are various challenges faced by residents' associations as they are not professional bodies with focus knowledge on neighbourhood's management. Besides the issues related to social and physical aspects, the lack of provision of roles in the guidelines presents challenges for the residents' association to govern their guarded neighbourhood. All matters regarding to community and neighbourhood will be tried to be resolved by the residents' association because they know better what happening in their neighbourhood. So, this paper will observe the challenges in governing guarded neighbourhood.

## 2.0 THE RESIDENTS' ASSOCIATION CHALLENGES

The responsibility of the association is not easy because every action taken involves matters pertaining to legislation and psychology that there are various obstacles that the residents' associations have to face as long as the work of governors is implemented. Progressively, the existence of residents' association will

result in more disputes between the unity of the residents and its communities (Kennedy, 1995). Indirectly, the roles played by the residents' associations can be regarded as the responsibility of the local authorities in safeguarding their governing areas.

The transfer of responsibility creates tensions on the residents' associations as non-governmental organizations because they are parties who voluntarily govern their neighbourhoods and have always been dependent on local governments (Henry, 2008). The residents' association is appointed by residents in a neighbourhood and certified by the Registry of Societies Malaysia (RoS). The problems seen in the context of Malaysia is not only touching on issues of physical planning and legal perspectives but also matters relating to social impacts over a long period of time (Wang, 2014). Figure 1 mentioned that residents' association usually faced the challenges as stated below:



Figure 1: Challenges in improving the quality of neighbourhood (Olima, 2013).

Challenges in community based governance especially in guarded neighbourhood has been shown in Figure 1 which give the impression that there is not easy approached that can be practised by residents' association to handle not only neighbourhood but also their community. Participation, supporting and collective action is the main challenges are related to community. For rules and regulation, the challenges are more focus

on the government side. All this challenges will be explained in sub topic 2.1 and 2.2 below.

## 2.1 *Internal governance of Residents' Association*

The residents is an important community that interacts with the residents' association. Good management will have a positive impact on the neighbourhood such as a more harmonious environment than the failure to seek cooperation from the residents. It is important to conserve good relationship between the parties managing the neighbourhood and the residents because the residents' association will be the group that will represent the people's conscience. Managing a big community is not an easy thing especially regarding to the house rules and how residents' association to sustain the house rules.

A large community will face various conflicts and difficulties to achieve consensus and legal requirements in ensuring all neighbourhood residents to follow the rules that have been prepared (Chen and Webster (2004). However, the study of Gibson and Koontz (1998) states that the existence of social interactions among communities is able to facilitate the achievement of collaborative and community outcomes (Ascher, 1995) demonstrating the need to create a good network of partnerships to achieve more successful management.

The problem of gaining cooperation from the residents can also affect the resident association. This is because the fact is that in neighbourhood governing requires the involvement of the residents so that the management will flow better. Generally, the study conducted by Yates (1972) stated that the conflicts often faced by a private government consisted of management in terms of time and opportunities, especially in persuading the population to cooperate with planned activities and issues involving collection of association fees. However, it is undeniable

that in a neighbourhood, only a few people have the confidence and time to engage in the administration of a neighbourhood as most residents do not like to attend meetings and activities (Robinson et al., 2005). The harder challenges to residents' association is when the residents' themselves refuse to participate any programs or meetings. In fact, the study conducted by Tedong et al., (2012) shows that having meetings with the residents is a very practical solution to overcome the problematic issues such as vandalism issues, street lighting damage, grass and road maintenance issues and so on. Through the meetings conducted, residents' associations can see the residents' response on their neighbourhood.

In terms of payment of fees, it is also a difficult problem to curb. Residents refuse to pay the service charge set by the designated resident association and the residents' association not easy to maintain a guarded neighbourhood because of not enough funding to manage it. In fact, the fees arrears are also often incurred that management is difficult to make around of payments such as to the security guard and the appointed party for maintenance scope like cleaning of residential areas and playgrounds as well in guarded neighbourhood.

This is usually the case with existing types of housing that agree to create a guild-based concept because of the lack of a security system in their neighbourhood has caused theft that ruin the residents in the housing. Such problems often occur to the self-organising communities because of not all residents agree to join the established community association. This is because, in the establishment of residents' associations, they cannot compel the inhabitants of a neighbourhood to join the association of the residents. Such a factor is one of the constraints inherent in governing a neighbourhood because the resident association has no authority to determine the amount of fees to be paid by the residents except through the consent of the residents, conducted by holding an annual meeting (McCabe, 2011).

The problems that are often discussed in the previous study are related to free-riders. The problems are often highlighted in the management as it involves the sharing of resources created in a neighbourhood and those facilities are used by all in the society. Previous studies state that those who are at the level of free-rider mentality always assume and believe that they are only benefiting from the efforts undertaken by others (Hardin, 1968). Free-riders do not only refer to residents in the neighbourhood but also those who are out of the neighbourhood that have the potential to become free riders as they have the potential to use the facilities provided without making any payment on the existed facilities.

Even in the study by Tedong et al., (2012) showed that 100% of the residents in the neighbourhood of Damansara agree to not to allow non-residents to enter their neighbourhood without any specific purpose on the reason that the resident has paid a maintenance fee of RM50.00 per month for their safety purposes. The fact is, the cost of collection of these fees would be easier if the participation of residents in a community association is compulsory for each resident so that the costs incurred to govern the neighbourhood would be equally distributed (Bowles and Gintis, 2002). The insufficient fees is the one factors contribute to the failure of guarded neighbourhood schemes. However, issues regarding free riding can be overcome by reducing monthly fees for maintenance so that residents in the neighbourhood do not feel burdened. This is verified by the Read (2008) study which states that collective action succeeds with reducing management fees and the fees are shared simultaneously.

## 2.2 Local authority Connectivity

Challenges for governing in guarded neighbourhood also rising because of missed communication between residents'

association and government. Based on Totikidis et al., (2005) studies reveal that the major reason overlapping boundaries within governing the neighbourhood because of they shared same aims of community which local authority also have responsibility for public amenities under Local Government Act 1976 (Act 171). The appointed residents' association in a neighbourhood have the responsibility to govern their guarded areas especially for safety and secure purpose.

Due to the background of the non-professional population, the residents' associations faced with problems in governing a guarded environment in delivering services with disadvantaged knowledge and experience (McCabe, 2011). In monitoring neighbourhoods, some issues cannot be solved individually and require support from more discerning parties such as the government (Bowles and Gintis, 2002) because in terms of legislation, the government provides legislation to address the problems arising primarily involving crime or controversial neighbourhood regulatory disputes. In Malaysia, the government such as Town and Country Planning Department provides a guideline as references to developers and residents those plan to setting up guarded neighbourhood, so they more vulnerable to the criteria set by the local government.

In Malaysia, practically, it still demonstrates the need for cooperation between the residents' association and the government, especially the local authorities. This is because the local authorities are more knowledgeable in matters pertaining to neighbourhood management. However, there are a few residents' association failed to follow the laws and regulations set by the authorities that it caused conflicts. For example, it is possible to establish a guardhouse permanently in the middle of the road even if the prohibition is generally stated. It becomes even more complicated when the authorities are monitoring and the residents' association are dissatisfied with the rules. It is a good effort for the government to interfere in the governing of

the neighbourhood because it is not only saving the cost but also the association of residents can also learn the neighbourhood management and report any crime that is happening in their neighbourhood. In terms of cost savings, as it is known, the government receives a provision known as MARRIS from the federal government to carry out maintenance-related work (National Parlimentary Documentation Branch, 2010). MARRIS known as Malaysian Road Information System or in Malay known as Malaysia's Records-Record Information System.

As each state government has these provisions, the residents' association has the advantage of applying the allocation to safeguard the security aspect in their neighbourhood by constructing a bump so that vehicles can slow down their vehicles especially near the playground. If there is a problem between the associations of the population and the government, it is quite difficult for the residents to administer better. A residents' association will be more creative if they are able to share their views with the government. Based on a study by Henry (2008), cooperation in administering would be easier if the government appreciated the views expressed by those directly involved in the governance.

## RESEARCH METHODOLOGY

The selected case study comprised the guarded neighbourhood which there are two ways of formation like formed by developers or residents initiative due to their awareness to increase their safety. Using guarded neighbourhood area in Johor Bahru within under Majlis Bandaraya Iskandar Puteri and Majlis Perbandaran Kulai, the research focus on explorative approach using qualitative methods. This research was conducted by depth interview session with residents' association to identify the challenges of their roles in governing guarded neighbourhood. The outcomes in this

research were combined primary and secondary data to strength the final findings. They are 11 of guarded neighbourhood schemes involved in this study that is Rini Hills, Rini Hills 2, Pulai Indah, Perdana Terrace, Fenix Villa, Pulai Perdana 2, Pulai Bayu, Presint Utama, Skudai Ria, Pulai Flora and Taman Perling.

## RESULT AND DISCUSSION

The research findings confirm that as a voluntary community, residents' association faced a lot of challenges due they are not expertise and no rules or specific guidelines to guide residents' association roles. The Department of Town and Planning prepared the guidelines only to ensure the developer or residents' association refer the guidelines regarding to physical aspects. Therefore, residents' association quite difficult to identify clearly their main task. The study suggests that residents' association need to clarify their responsibility clearly to their neighbourhood so at the same time the residents' association will alert if anything happened in their neighbourhood.

Based on the depth interview shows that management aspects is one of the main challenges to residents' association governing such as issues on clerical staff and fees. Another issues related to management is developer commitment, office issues, and access card. All this matters need consideration to extra attention because most problem faced by residents' association are same in every guarded neighbourhood in Malaysia.

**Table 1:** Problems in guarded neighbourhood

| Participate | Safety | | | | | Management | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Vehicle Speed | Kids Play ball | Outsider Trespass | Abandoned Tree | Pets | Developer Commitment | Office | Clerical Staff | Fees | Access Card |
| Rini Hills | √ | √ | | √ | √ | | √ | √ | | |
| Rini Hills 2 | | | | | | | | √ | √ | |
| Pulai Hijauan | | | | | | | | | √ | |
| Perdana Terrace | | | | | | | | | √ | |
| Pulai Perdana 2 | | | | | | | | | | |
| Fenix Villa | | | | | | √ | | | | |
| Pulai Bayu | | | | | | | | | | |
| Presint Utama | | | | | | | √ | √ | √ | √ |
| Skudai Ria | | | | | | | | | | |
| Pulai Flora | | | √ | | | | | √ | √ | |
| Taman Perling | | | | | | | | √ | | |

From table 1 showed that for safety aspect, even the reason of guarded neighbourhood established because of community need to live in peaceful place but the interview reveal that management aspect is very important to be considered. Five of the neighbourhood agree that the most challenges in their management are related to the issues of clerical staff which is less participatory will give impact to daily supervision. From Islamic perspective state that leadership and management factors can determine a good governance. Besides that, issues related to fees also give a big challenges because all things involves the money. Another challenges related to the purpose of community safety are speeding of vehicle, trespassing and pets. All this challenges will become worst if no action taken by residents association. From the results, the suggestion to overcome the challenges is residents' association must identify the best way to manage finance because there a lot of scope in governing the guarded neighbourhood especially if the neighbourhood have common interest and also seek to invite the community together in the governance of guarded neighbourhood. Collaboration between

government, residents' association and community is the best combination of good governance in way to overcome the challenges.

## CONCLUSION

Residents' association are the most important parties in guarded neighbourhood management because of their initiative to ensure their neighbourhood more safety and secure and they more understand the scenario of their neighbourhood. The roles of residents' association in community based governance is the best approach in attracting community to involve in society activity. Despite the various challenges faced by residents' association, the voluntary nature has encouraged the association to be devoted to their neighbourhood. Basically, residents' association need to understand the guideline provide by JPBD especially in physical aspect to avoid any problems related to formation of guarded neighbourhood. Besides that, in managing the neighbourhood without any specific roles, residents' association should be more flexible to adapt the situation based on community behavior and also guarded neighbourhood conditions. This bottom-up approach giving the chance to community because they know better what they want.

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# AN OVERVIEW OF THE HOUSING TENURE TREND IN MALAYSIA

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## ABSTRACT

According to Maslow's Hierarchy of needs theory, housing is one of the basic human needs. Housing tenure can be categorised into homeownership and renting. Malaysia is considered a "homeownership nation" primarily due to the high homeownership rate of 77% recorded in 2019. However, the homeownership trend in Malaysia, particularly in urban areas, is expected to decline due to rising housing costs. This paper aims to provide an overview of the housing tenure choice among Malaysian. The housing tenure trend in Malaysia and the factors that influence Malaysian's intention to purchase or to rent a house will be discussed in this paper. This paper will provide insights on the housing tenure preferences of Malaysians and assist the government in formulating policies to ensure that all citizens are able to own or rent housing.

*Keywords : Rent, Own, Housing Tenure, Malaysia*

## INTRODUCTION

In Maslow's Hierarchy of needs theory, all the human needs are ranked in order to importance, including air, water, food, shelter, sleep, clothes, warmth and so forth (Maslow, 1954). A structure of five-tiered of hierarchy of human needs is proposed by Maslow (1943) including needs for physiological, needs for safety, needs for belongingness and love, needs for esteem as well as needs for self-actualization. According to Maslow (1943), physiological needs known as a fundamental requirement for human survival, encompassing necessities such as water, food, air as well as shelter. Hence, housing is categorised as a physiological need in Maslow's Hierarchy of Needs Theory. Likewise, Petrus (2012)

also argues that housing is the most essential element of human physical survival.

Besides, housing also plays an important role for people's well-being since it can satisfy the demands for love and belongingness, protection and security as well as for their physical and mental health (Abidoye et al., 2021). In the past, housing market has been a significant sector to the nation's economy due to its close ties to many industries and sectors (Mohd Thas Thaker & Chandra Sakaran, 2016). People can acquire housing through either homeownership or renting. Housing tenure choice can be known as the most crucial financial choice during people's lifetimes (Huber & Schmidt, 2022).

However, homeownership or renting can be a good choice (Nurhayati et al., 2019).

Homeownership is the most popular choice in housing tenure especially in developed countries or developing countries (McKee, 2012; Tan, 2008) since it provides a wide range of benefits, such as enhancing people's life satisfaction (Angel & Gregory, 2021), promoting greater happiness among individuals (Hu & Ye, 2020; Fong et al., 2021; Seiler Zimmermann & Wanzenried, 2019) as well as serving as a superior investment option compared to other assets (Tan, 2008). Besides, housing not only serves as a shelter but also an underutilised savings for the time being as well as retirement savings (Haffner, 2008; McCabe, 2018). Other than that, according to the research carried out by Bryx et al. (2021) in Poland focused on millennials, homeownership also offers a sense of security and stability as well as offer a high-quality life to millennials, the majority of whom, particularly millennials aged 26 and above prefer to become homeowners.

Although homeownership provide a lot of benefits, however the homeownership trend has changed to renting trends. According to the research carried out Hulse and Yates (2017) in Australia argues that the demand for renting has increased across the board of income levels. Some individuals perceive renting is a more financially feasible option (Fuster et al., 2019; Zheng et al., 2019; Bayrakdar et al., 2019), enable them to change their job easier (Li et al., 2022), secure, attractive, as well as generally accept by the cultural (Bayrakdar et al., 2019). In addition, renting a house offers the tenant to decide which location is more desirable based on their incomes, and enable them to have a higher standard living (Hulse & Yates, 2017).

The decision in choosing to own or rent a house can be influenced by various factors. Among the factors are demographic factors including age, level of education, monthly salary, marital status as well as employment (Si & Yi, 2018; Tan, 2022; Clark et al., 2021), financial factor including housing prices, interest rate as well as mortgage (Fuster et al., 2019; Mariadas et al., 2019; Nurhayati et al., 2019; Mohd Thas Thaker & Chandra Sakaran, 2016; Si & Yi, 2018; Sekkat & Szafarz, 2011) and environmental factor including neighbourhood (Mohd Thas Thaker & Chandra Sakaran, 2016; Mariadas et al., 2019; Khan et al., 2017; Zrobek et al., 2015).

Hence, the aim of this study is to provide an overview of the housing tenure choice among Malaysian including the meaning of housing tenure choice in Malaysia, the housing tenure trend in Malaysia and the factors that influence Malaysian's intention to purchase or to rent a house. A review of prior literature related to the topic was conducted and the data from article papers, conference or proceeding papers, published reports, as well as websites were collected and reviewed.

## METHODOLOGY

The aim of this study is to provide an overview of the housing tenure choice among Malaysian. To accomplish the objective of this study, content analysis has been performed in the present study. As indicated by Seuring and Gold (2012), content analysis is acknowledged as an useful instrument for performing a transparent and systematic literature review. The searches were conducted by using multiple databses including Web of Science database, Scopus database and Google Scholar database. The search terms used to identify the relevant materials encompassed terms such as "housing tenure", "homeownership", "renting", "own", "rent" and "Malaysia. Besides, the selected research materials published in the year ranging from 2008 to 2023 were used in the present study. These materials include article papers, published reports, conference proceeding paper as well as websites. Only literature published in English language was included in the review for present study.

The results and discussion are presented in the next section.

## MAIN RESULTS

Homeownership can be viewed as a sign of success or a credential of citizenship in America (McCabe, 2018; Judge et al., 2019; Foye et al., 2018). Besides, people also tend to view homeownership as a sense of ontological stability (Saunders, 1989). Malaysia can be considered as a homeownership nation mainly due to the high homeownership rate recorded at 77% in 2019 and homeownership has been priority choice for most of the Malaysian compared to renting although they might still unaffordable especially the millennials (Tan, 2008; Hamzah & Zyed, 2021). According to Yaacob et al. (2022), Malaysia has more focused on homeownership instead of rental and the housing policies in Malaysia are more heavily focused on homeownership (Hamzah & Adnan, 2016). However, due to the housing issue such as the high housing prices that unaffordable by households (Ismail, 2021), nowadays, a portion of Malaysians are more prefer to rent their house instead of to own their house (Ag Anuar & Abdul Wahab, 2022).

In order to identify the perception of Malaysian in housing tenure choice, Nurhayati et al. (2019) carried out a research focused on the young professional who live in major cities found out that the concept of renting is now being embraced by most of the young professional. The renting culture scenario accepted by young professionals mainly due to the housing price keep rising that unaffordable by them and renting as alternative way that only required to pay for monthly rentals fees which roughly 50% less than monthly housing loan. In the same vein, report of HSBC (2017), titled "Beyond the Bricks" also claims that only 35% of youth in Malaysia are homeowners. Besides, percentages of searches for rental property in iProperty.com.my website rose by 34% in H1 2022, indicated that the rental market

in Malaysia was expected to expand going forward (Prasad, 2022). The homeownership trend has faced a decrease in urban areas (National Housing Department, 2018) mainly due to the rising housing prices.

Generally, when deciding whether to purchase property, people will weigh both internal and external factors since it involves a substantial amount of money, a number of phases as well as a long-term commitment (San, 2016, Hassan et al., 2021; Aziz et al., 2022). According to Mohd Thas Thaker and Chandra Sakaran (2016), housing prices has the most significant impact on Malaysian's buying decision. Besides, according to the research carried out by Si and Yi (2018) in Selangor, Malaysia, it found out that financial assessment has the most significant impact on the intention of Malaysian in owning a house since owning a house entails a large commitment that require mortgage repayments. In the same vein, Mohd Thas Thaker and Chandra Sakaran (2016) also claims that homebuyer's financial status has impact on Malaysian's buying decision.

Other than that, homebuyer purchase decision also influenced by the amenities around neighbourhood (Mohd Thas Thaker & Chandra Sakaran, 2016; Mariadas et al., 2019; Khan et al., 2017) and the location of the house (Thanaraju et al., 2019; Mohd Thas Thaker & Chandra Sakaran, 2016; Khan et al., 2017). In addition, structural factors (Mohd Thas Thaker & Chandra Sakaran, 2016; Khan et al., 2017), facilities in the house as well as developer (Mohd Thas Thaker & Chandra Sakaran, 2016) also have impact on homebuyer purchase decision.

According to Si and Yi (2018), the intention of consumer in owning or renting a house also impacted by demographic factor including household's education level and monthly salary have impacted on their intention in owning or renting a house meanwhile their marital status has not impacted on their intention. Household with high education level and monthly

salary will more prefer to own a house compared to rent (Si & Yi, 2018). Likewise, Tan (2022) also argues that the during decision making, homebuyers with high education level such as Doctoral degree does not significant impacted by herding behaviour including the preferences of their family, friends, third force as well as other homebuyer since they were more independents during the process of decision making.

Furthermore, housing price not only impact on the intention of the homebuyer in owning a house but also impact on the intention of the tenant's decision in renting a house (Nurhayati et al., 2019). Other than that, the intention of the tenant's decision also will be impacted by following factors including no real estate taxes required, easy to access the amenities around the neighbourhood, freedom in searching their dream house, the cost of maintenance for a house is low as well as able to live in high-cost area (Nurhayati et al., 2019; Ag Anuar & Abdul Wahab, 2022).

## CONCLUSION

In sum, an overview of housing tenure in Malaysia concluded that the homeownership trends in Malaysia has slowly move to renting trends due to the rising housing prices. The findings expected to provide a reference to the government in policy making in order to ensure all the citizens enable to own or rent their housing Therefore, the direction for further research needs to come up with the strategy in encourage the people to rent or own their house based on the affordability. Besides, the further research also needs to focus on rental market in order to fulfil the knowledge gap in housing tenure in Malaysia.

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# A REVIEW OF TRANSIT-ORIENTED DEVELOPMENT FOR THE IMPROVEMENT OF PUBLIC AMENITIES IN MALAYSIA

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## ABSTRACT

The purpose of this paper is to explore the implementation and impact of Transit-Oriented Development (TOD) on public amenities in Malaysia. TOD known as an urban design approach aimed to enhanced public spaces and amenities through sustainable development around transportation hubs. This study aims to examines specifically the situation in Malaysia and analyse the effectiveness of TOD in improving urban public facilities. This paper focus to determine the main goals of TOD development in Malaysia, such as land use efficiency, minimize traffic congestion, improving access to public transport, and creating liveable communities. This paper also examine the role of mixed-use development, pedestrian-friendly infrastructure, and densification in the design of public facilities in the TOD area. Furthermore, this study explores the specific benefits of TOD for public amenities in Malaysia. TOD are developed not only to benefit and improve the welfare of resident, but it creates the integrated public spaces such as parks, religious facilities and recreational areas to promote community participation. Besides that, proximity to essential services such as schools, medical facilities and shopping malls was also examined focusing on the convenience and accessibility TOD provides. There are several challenges faced in the TOD implementation in Malaysia and proposes strategies to be highlight in this research paper. Key factors for the success of TOD projects determined by the effective cooperation between the public and private sectors, government support policies, and community involvement. The research method used for this paper is qualitative research. A comprehensive analysis of related statutes, rules and regulations, research papers, journals, articles, thesis and electronic materials will be conducted. This research paper will highlights the importance of sustainable urban development, reduced environmental impact and improved quality of life for Malaysians.

*Keywords : Transit-Oriented Development (TOD), public amenities, sustainable development*

## INTRODUCTION

As urban facilities in Malaysia confront the demanding situations of fast urbanization and the need for sustainable development, progressive techniques are pursued to enhance public services and improve residents' overall quality of life (Saadatian et al., 2012). Transit-Oriented Development (TOD) is a potential urban layout idea that combines land use and transit planning to create active, accessible, and environmentally-friendly communities. TOD promotes efficient and sustainable transportation, reduces congestion, and improves public spaces and facilities through growing mixed-use neighborhoods around transportation hubs. This study analyzes how TOD influences Malaysian public services. It examines how TOD public facilities shape mixed-use development, pedestrian-friendly infrastructure, and densification. By critically analyzing the effectiveness of TOD in improving urban public facilities, this research aims to provide valuable insights into the benefits and challenges of implementing TOD in Malaysia. The findings of this study will contribute to the knowledge base of urban and environmental planning, offering recommendations to policymakers and stakeholders on strategies to enhance public amenities and foster sustainable urban development. Ultimately, this research underscores the significance of TOD as a catalyst for reduced environmental impact and improved quality of life for Malaysians.

## METHODOLOGY

The methodology employed in this research paper adopts a qualitative research method to discover the implementation and effect of Transit-Oriented Development (TOD) on public services in Malaysia (Tenny et al., 2017). The qualitative approach allows for intense analysis and understanding of the complex social, financial, and environmental factors related to TOD.

Data collection techniques involve a comprehensive review of relevant sources, which include statutes, guidelines and regulations, research papers, journals, articles, theses, and electronic materials (J. Yap et al., 2017). These sources offer valuable insights into the current state of TOD and its impact on public services in Malaysia. The accrued information is then analyzed using qualitative analysis strategies to identify relationships associated with the effectiveness of TOD in improving public amenities. This analysis helps to find the strengths and weaknesses of TOD implementation and its impact on the quality and accessibility of public facilities in Malaysia.

All these materials provide valuable knowledge about the current condition of TOD (transit-oriented development) and its influence on public services in Malaysia. After accumulating this information and connections linked to how effective TOD is at enhancing public facilities. This analysis helps to find the strengths and weaknesses of TOD implementation and its impact on the quality and accessibility of public facilities in Malaysia.

## LITERATURE REVIEW

### Role Of Mixed-Use Development In TOD Areas

Mixed-use development integrates various land uses within a single improvement, promoting convenience and accessibility for residents. It combines residential, industrial, and leisure additives, creating vibrant communities where humans can live, work, and play close to them (Abdul Latip et al., 2023). In TOD areas, combined-use improvement undoubtedly impacts public facilities by incorporating amenities that cater to the community's needs. This integration includes public spaces, parks, libraries, and network centers, improving citizens' ordinary quality of life. By reducing the need for long commutes, combined-use

improvement fosters a sustainable and walkable environment (Czarnetzki et al., 2022).

Successful examples of mixed-use development in Malaysia encompass the Kuala Lumpur Sentral location, a mixture of residential, commercial, and leisure facilities integrated around a transportation hub (Azian et al., 2023). Similarly, the Bandar Utama township in Petaling Jaya gives a well-designed combo of residential, industrial, and recreational factors, which include a vibrant shopping center and a central park (Ju et al., 2011). These examples exhibit the benefits of blended-use improvement in TOD regions, developing dynamic and sustainable communities.

## Importance Of Pedestrian-Friendly Infrastructure In Tod Areas

Pedestrian-friendly infrastructure plays an essential function in TOD areas by promoting walking as a sustainable mode of transportation and enhancing the pedestrian experience. It offers improved safety, increased walkability, and enhanced connectivity (Alawadi et al., 2021). Pedestrian-friendly infrastructure influences the design of public facilities within TOD regions, ensuring their accessibility by foot (Ali et al., 2021). Sidewalks, pedestrian bridges, and services like seating and color are strategically deliberate to connect public facilities to transit nodes and different locations. Examples of successful implementation of pedestrian-pleasant infrastructure in Malaysia consist of widened sidewalks, pedestrian bridges, and devoted crossings inside the Bukit Bintang region, and well-designed pedestrian pathways and crossings inside the Ara Damansara TOD mission (Hamidun et al., 2013). These examples demonstrate how pedestrian-friendly infrastructure improves the accessibility and usability of public facilities, contributing to a more vibrant and sustainable TOD environment.

## Densification And Its Impact On Public Amenities In TOD Areas

Densification in Transit-Oriented Development (TOD) regions entails increasing population and building density to create colorful communities focused around transit hubs (Samant, 2021). Densification maximizes the usage of public facilities and transportation infrastructure, selling efficient land use and lowering vehicle dependency. By growing populace density, TOD areas can support various public centers within walking distance, including parks, colleges, healthcare facilities, and leisure spaces (Yu et al., 2022). This enhances the accessibility and viability of public services, reducing travel distances and promoting a sustainable lifestyle.

One notable case study demonstrating the impact of densification on public amenities in a TOD area is the Bandar Sunway improvement in Selangor, Malaysia (Xi et al., 2016). This location has enormous skilled densification with the development of high-upward push residential buildings, industrial complexes, and educational establishments across the Sunway-Setia Jaya BRT (Bus et al.) station. The densification has resulted in the provision of numerous public services, such as Sunway Pyramid shopping center, Sunway Lagoon theme park, and Sunway Medical Centre, all within strolling distance of the transit station.

The accelerated population density has additionally supported the development of parks, pedestrian-friendly walkways, and community spaces, growing a vibrant and accessible environment for residents and visitors (Speirs, 2019).

## Specific Benefits Of TOD For Public Amenities In Malaysia

Transit-Oriented Development (TOD) in Malaysia brings specific benefits to public amenities, improving citizens' overall quality of life. In TOD regions, integrated public areas play a crucial role in fostering a sense of community and promoting

social interaction. This includes the provision of parks and recreational areas that provide green spaces for leisure activities and promote a healthy lifestyle (Rahmat et al., 2016). Additionally, TOD areas frequently incorporate religious spaces, which include mosques or temples, providing accessible places of worship for citizens. Malaysian TOD benefits from proximity to critical services. TOD residents have convenient access to schools and educational institutions, decreasing travel and fostering a sustainable lifestyle (Pojani et al., 2015). Clinics and hospitals in TOD zones provide convenient healthcare services. TOD areas also have shopping malls and commercial centers with many retail, dining, and entertainment options within walking distance. TOD also encourages community involvement. The design of TOD regions encourages social interaction, creating opportunities for residents to interact with one another and build a strong sense of community (Abdul Aziz, 2017). Public services and areas within TOD areas often host community activities, fostering community cohesion and participation.

## Importance Of TOD For Essential Service In Malaysia

The convenience and accessibility offered by Transit-Oriented Development (TOD) in Malaysia extend to the provision of essential services. TOD areas are planned to guarantee that residents can easily reach imperative facilities like schools, medical centres, and shopping malls. As a result, the community's overall well-being is improved, enhancing their quality of life. A case study that exemplifies the convenience and accessibility of essential services in a TOD area is the KL Eco City development in Kuala Lumpur. This mixed-use development features residential, commercial, and office spaces integrated around the Abdullah Hukum LRT (Light et al.) station. The TOD area includes educational institutions such as The University of Malaya, hospitals like Universiti Malaya Medical Centre, and the Mid Valley Megamall, a popular shopping

destination. TOD creates a dynamic, accessible community by connecting the transport station to these critical services.

TOD areas in Malaysia also regularly function as medical facilities and clinics near residential neighborhoods (Rahmat et al., 2016). This ensures citizens have a handy get right of entry to healthcare services, decreasing the need for long commutes and improving essential well-being. Shopping malls and business centers are also commonly incorporated into TOD developments, supplying a wide range of retail, dining, and enjoyment alternatives within taking walks distance. This enhances convenience, supports neighborhood organizations, and stimulates economic activity.

## Challenges In The Implementation Of TOD In Malaysia

The implementation of TOD in Malaysia faces various challenges. These include issues associated with land availability, infrastructure improvement, and financing. Successful implementation requires identifying and analyzing these challenges. Public-private cooperation is essential to tackle these difficulties (Ramlan et al., 2021). Collaboration between developers, local authorities, and transportation agencies can cause integrated planning and coordinated efforts. Supportive government policies, such as incentives for TOD initiatives and streamlining regulatory processes, can facilitate implementation (Ho et al., 2011). Community involvement and engagement are vital components of successful TOD projects. Encouraging public participation through community consultations and workshops fosters a sense of possession and guarantees that the improvement meets the wishes of the local people (Slotterback, 2010). Additionally, raising public cognizance about the advantages of TOD and promoting sustainable transportation alternatives can assist in triumph over resistance and garner aid for implementation. Strategies and recommendations for successful TOD implementation in Malaysia include

adopting a long-term attitude, conducting comprehensive feasibility studies, and integrating TOD into broader urban planning frameworks (Yusoff et al., 2021). By addressing those challenges and implementing appropriate strategies, Malaysia can unlock the full potential of TOD and create sustainable and livable communities.

## Land Availability

One of the widespread challenges in enforcing TOD in Malaysia is providing suitable land for improvement. Finding appropriate sites strategically located near present or planned transportation hubs may be a complex undertaking. The shortage of to-be-had land and the need for efficient land use planning pose demanding situations to enforce TOD initiatives successfully. Furthermore, Azmi et al. (2021) pointed up that a crucial element in meeting the policymakers' gaps in Malaysia's TOD policy formulation related to incompatible zoning and land use laws.

## Infrastructure Improvement

Another challenge is the need for significant infrastructure improvements to support TOD initiatives. Integrating transportation structures, including rail networks and bus services, with land development calls for enormous investments in infrastructure. Upgrading current transportation structures and developing seamless connections between distinct modes of transportation can be a complicated and costly challenge.

## Financing

Financing TOD projects is another critical challenge. High amount of cost and regular maintenance requirement had been identified as part of the issues and challenges (Khaderi et al., 2021). The initial investment required for infrastructure improvement and land acquisition may be sizeable. Securing investment from public and private assets and ensuring the financial viability of TOD initiatives can pose challenges. Innovative financing mechanisms, including public-personal partnerships and value capture, must be explored to attract funding and triumph over monetary barriers.

## Policy

To address these demanding situations and ensure successful TOD implementation in Malaysia, it is recommended to undertake a long-term perspective, conduct complete feasibility studies, and combine TOD into broader urban planning frameworks. Furthermore, supportive authorities' policies, incentives for TOD tasks, and streamlining regulatory approaches can facilitate implementation and inspire personal quarter participation (Ho et al., 2011). By addressing these challenges and implementing suitable strategies, Malaysia can unencumber the total ability of TOD and create sustainable, livable communities.

## CONCEPTUAL FRAMEWORK OF TRANSIT-ORIENTED DEVELOPMENT (TOD)

### A. Definition and principles of TOD

Transit-Oriented Development (TOD) is an urban planning approach that aims to create sustainable and vibrant communities by integrating land use and transportation systems (Liang et al., 2020). Peter Calthorpe codified the concept of Transit-Oriented Development (TOD) in the late 1980's while others had promoted similar concepts and contributed to the design. TOD became a fixture of modern planning when Calthorpe published "The New American Metropolis" in 1993 (Carlton, 2009). Calthorpe wrote that TOD was "a mixed-use community within an average 2,000-foot walking distance of a transit stop and a core commercial area" (Calthorpe, 1993) (Figure 1).
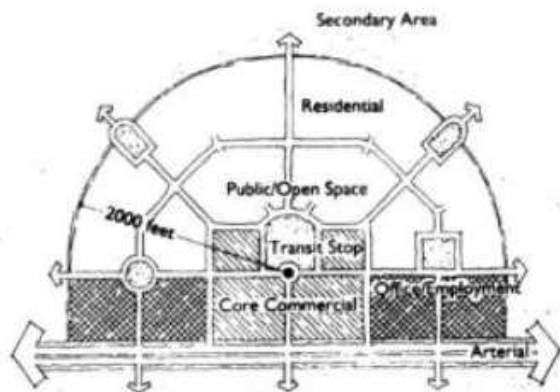
**Figure 1** Transit Oriented Development (Calthorpe 1993, 56)

TOD is characterized by compact, mixed-use improvement focused on outstanding public transportation hubs, including train or bus stations. It seeks to reduce dependence on private cars, promote lively modes of transportation like walking and cycling, and enhance accessibility to public transit alternatives. TOD follows numerous concepts to achieve its goals (Noland et al., 2017). The core of TOD is the integration of land use and transportation systems, which leads to the compact development of urban spaces around transit nodes. This compactness promotes walkability, as various amenities and facilities are within a short distance from one another (Zhang et al., 2011). These encompass promoting a mixture of land uses, such as residential, commercial, and recreational, to create diverse and dynamic neighborhoods. The layout of TOD areas specializes in developing pedestrian-pleasant environments with walkable streets, enough sidewalks, and well-linked pathways.

In Malaysia, the concept of TOD was first initiated in 2005 (Azmi et al., 2021). The potential of TOD in Malaysia is supported by the increasing preference for LRT travel over private vehicles among city dwellers (J. Yap et al., 2017). The implementation of TODs in Malaysia has been discussed in various studies (Abdullah et al., 2020; Azmi et al., 2021; Khaderi et al., 2021; Kidokoro, 2020; Ramlan et al., 2021; Sabri et al., 2013; Shah et al., 2020; Sidek et al., 2020). Factor includes residential developments, transit stations, land use, economic activities, and ridership numbers had been considered

## B. MAIN GOALS OF TOD DEVELOPMENT IN MALAYSIA

### Land use efficiency

TOD in Malaysia aims to optimize land use by promoting higher-density improvement around transit nodes. By concentrating on improvement near transportation hubs, TOD reduces urban sprawl, which preserves precious inexperienced areas and agricultural land (Azmi et al., 2021). The compact and green land use patterns in TOD regions bring about shorter tour distances, decreased journey times, and more efficient use of infrastructure. This intention aligns with the targets of the National Physical Plan and State Structure Plans in Malaysia, which emphasize sustainable land use-making plans and efficient, helpful resource usage (Jafarpour Ghalehteimouri, 2020).

### Minimizing traffic congestion

One of the critical goals of TOD in Malaysia is to decrease traffic congestion by providing convenient and accessible public transportation options. TOD encourages a modal shift from personal vehicles to public transport, lowering the number of cars on the street (J. B. H. Yap et al., 2017). TOD makes public transportation for daily commutes easier by placing schools, workplaces, and commercial areas near transit nodes. Traffic, carbon gas emissions, and urban air quality improve.

### Improving access to public transport

TOD development in Malaysia strongly emphasizes enhancing access to public transportation centers. This entails designing TOD regions to offer seamless and handy connections between residential and business areas and public transit options. Walkability is a crucial precept of TOD, which emphasizes creating pedestrian-friendly environments

that facilitate access to transit stations (Gomez et al., 2019). Integrated transport hubs and well-designed pedestrian networks ensure that citizens have convenient and efficient access to public transport services, encouraging greater use of sustainable modes of transportation.

## Creating livable groups

TOD aims to create livable groups that enhance the exceptional of life for citizens. By promoting a mixture of land use within proximity, TOD guarantees that residents can access a wide range of amenities, offerings, and leisure possibilities (Iuchi et al., 2013). Integrating residential, business, and leisure areas creates colorful and dynamic neighborhoods. TOD areas prioritize the advent of public spaces, consisting of parks, plazas, and community facilities, which serve as gathering places and promote social interaction among citizens (Altoon et al., 2011). The design of TOD regions also considers elements inclusive of safety, aesthetics, and a feel of the area, contributing to creating inclusive and livable communities.

## CONCLUSION

The study specializes in the essential elements for the success of TOD projects in Malaysia. It highlights the significance of practical cooperation between the public and private sectors, supportive government policies, and community involvement. These factors significantly shape the results and sustainability of TOD projects, ensuring long-term advantages for each citizen and the wider community.

### Improving Public Services in Malaysia

This research paper's finding suggest that TOD positively affects improving public services in Malaysia. The analysis reveals that TOD contributes to creating incorporated public areas, parks, recreational areas, and religious spaces, which enhance community participation and well-being. The proximity of essential services, which include schools, medical facilities, and shopping malls, also improves convenience and accessibility for residents.

### Enhance Urban Development & Sustainibility

Transit-Oriented Development (TOD) has the potential to significantly enhance public services and urban development in Malaysia, focusing on three major areas: sustainable urban development, reduced environmental impact, and improved quality of life. By integrating land use and transportation, TOD promotes sustainable communities with improved access to essential services and incorporated public areas. The analysis of TOD's effectiveness in Malaysia highlights its positive impact on public services and the significance of factors which include mixed-use development and pedestrian-friendly infrastructure.

### Recommendations

TOD implementation require cooperation among sectors, supportive policies, and community involvement. Embracing TOD principles can cause sustainable urban improvement, decreased environmental impact, and advanced quality of life for Malaysians. Therefore, continued research and collaboration are essential to further optimize the implementation and advantages of TOD within the Malaysian context. Successful implementation requires careful planning, coordination, and community engagement to ensure that TOD projects align with the needs and aspirations of local residents.

In conclusion, Transit-Oriented Development (TOD) can enhance public services in Malaysia and represents a promising approach to creating sustainable, accessible, and vibrant urban environments. TOD can reduce reliance on private vehicles, enhance mobility, promote social equity, and stimulate economic growth. By integrating land use

and transportation, TOD promotes sustainable communities with improved access to essential services and incorporated public areas. The analysis of TOD's effectiveness in Malaysia highlights its positive impact on public services and the significance of factors which include mixed-use development and pedestrian-friendly infrastructure.

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# LEGAL ACTION OVER ABANDONED RURAL RESIDENTIAL LAND UNDER NLC 1965

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## ABSTRACT

Due to the rapid and widespread rural-to-urban migration in Malaysia, rural residential land is gradually being abandoned. Although several studies have investigated the causes and effects of abandoned land, there needs to be more emphasis on developing legal procedures to avoid and resolve the issue of abandoned rural residential land. Knowing how valuable the land is, each nation would govern its own state's land using its legislation. The National Land Code of 1965 became the main Act used to govern land-related laws in Malaysia. Therefore, this paper is to examine the current legal action over abandoned rural residential land under National Land Code 1965. The research aims to provide a comprehensive view of the role of the NLC 1965 in governing abandoned land issues in Malaysia. Ultimately, the study's outcomes may serve as a basis for formulating recommendations and strategies to safeguard rural land resources amidst the pressures of urbanization while promoting responsible land use in rural areas.

*Keywords: Abandoned Land, Rural Residential Land, National Land Code 1965*

## 1.0 INTRODUCTION

In recent years, Malaysia has witnessed a notable trend of rural-to-urban migration, wherein individuals are increasingly relocating from rural regions to urban areas in pursuit of improved prospects and living standards (Ngah, 2012; Hussain et al., 2015; Abdullah et al., 2019). The demographic transition has resulted in the desertion of rural residential areas (Liu et al., 2010; Zhou et al., 2021) that once thrived with active communities and agricultural practices. Consequently, the issue of rural land abandonment has emerged, posing a multitude of intricate challenges to the socio-economic well-being and sustainable utilisation of rural land. The matter pertaining to abandoned rural residential land gives rise to apprehensions concerning land resource

management, the decrease in agricultural productivity, and the environmental ramifications (Cohen, 2001; Schilling, 2002; Silverman et al., 2013; Morckel, 2013). To effectively tackle this issue, it is imperative to establish robust legal protocols that safeguard land rights and foster sustainable land utilization.

While numerous studies have explored the causes and effects of abandoned land, there remains a pressing need to focus on developing legal procedures to address this issue in rural areas effectively. Understanding the value of land for its own sake, individual nations exercise authority over the management and regulation of their territories through legislation customized to address specific requirements. In Malaysia, the NLC 1965 is the principal Act governing land-related laws, serving as the cornerstone of land governance in the country. Against this backdrop, this paper is to examine the current legal action over abandoned rural residential land under NLC 1965. This research aims to provide a comprehensive view of the role of the NLC 1965 in addressing the issue of abandoned land.

## 2.0   ABANDONED RURAL LAND

Scholars and researchers from various academic subjects have developed a keen interest in the problem of abandoned land, particularly in the context of migration from rural to urban areas (Liu *et al.*, 2010; Nam *et al.*, 2016; Abdullah *et al.*, 2022; Wang *et al.*, 2021). The research endeavours have generated significant findings regarding the complex interaction of diverse elements contributing to rural residential land abandonment.

Urbanisation is widely recognised as a significant factor contributing to the depletion of agricultural land in rural regions (Liu *et al.*, 2010; Liu, 2018; McGreevy, 2012). According to Todaro, how long the present value of the expected urban income exceeds the rural income, the migrant will prefer to migrate. The phenomenon generates many employment prospects, prompting individuals and families in rural regions to relocate to urban areas for enhanced job prospects, improved educational accessibility, and modern conveniences (Ghafouri *et al.*, 2015; Manakou, 2018; Li *et al.*, 2016; Song *et al.*, 2014; Zhang *et al.*, 2016; Yang, 2017; Semprebon *et al.*, 2019; Liu *et al.*, 2020). Individuals relocating from rural regions to urban centres significantly alters population distribution, thereby abandoning rural territories (Liu *et al.*, 2010; Yang, 2017; Li *et al.*, 2014). Alterations in lifestyles and shifts in the makeup of society are also significant contributors to land abandonment (Nam *et al.*, 2016; Li *et al.*, 2016; Zhou *et al.*, 2020). They prefer to migrate to urban areas, further distancing themselves from traditional agricultural practices and rural life, while newer generations increasingly embrace more vibrant and urban-centric lifestyles. This slow but steady shift in preferences towards city living makes the process of rural land abandonment even more pronounced.

In addition to societal transformations, demographic trends such as decreased birth rates and ageing populations in rural regions (Owen, 1996; Machline *et al.*, 2017; Tani *et al.*, 2016) contribute to lower labour availability for agricultural operations, making rural lifestyles less sustainable (Zhang *et al.*, 2016; Ivolga, 2014; Long *et al.*, 2010). This results in fewer people being able to participate in agricultural work. Because of this, large swaths of land in rural residential areas are left uninhabited and untouched by cultivation as a direct result of population movements combined with urban migration. The environmental condition is an additional significant factor that influences the phenomenon of land abandonment (Liu *et al.*, 2010). Environmental degradation caused by deforestation, soil erosion, and the depletion of natural resources results in the unsuitability of certain lands for continued agricultural activity (Zhou *et al.*, 2021; Guler *et al.*, 2019). This phenomenon motivates rural populations to seek economically advantageous

alternatives in different regions. Similarly, land degradation due to overexploitation or unsuitable land-use practices can lead to decreased agricultural productivity, prompting land abandonment as a consequential outcome (Liu *et al.,* 2010; Guler *et al.,* 2019).

In rural-to-urban migration, the current corpus of literature on abandoned land gives useful insights into the delicate nexus of socio-economic, environmental, and demographic issues that drive land abandonment. To formulate effective policies and interventions to address the issues posed by abandoned rural residential land, it is necessary to understand the underlying reasons fully. By acquiring a nuanced understanding of these factors, policymakers and other stakeholders can develop targeted strategies to mitigate the negative effects of rural land abandonment, promote sustainable land use, and foster the resiliency of rural communities in the face of the pressures of urbanisation and shifting societal dynamics.

## 3.0   THE LEGAL ACTION
### 3.1   *Overview of the NLC 1965*

In this section, the research provides an overview of the NLC 1965, the primary legal instrument governing land laws in Malaysia. It was introduced in 1965 and has undergone several amendments since then to adapt to current needs. The NLC 1965 serves as a comprehensive legal framework to regulate and control land administration, land ownership and land use throughout the country. This subsection is to elucidate the fundamental principles and objectives embedded within the NLC 1965, which govern land-related matters in the country.

Land ownership stands as a foundational pillar of land governance, bearing significant ramifications for diverse land-related concerns, including the intricate issue of abandoned rural residential land. In the context of the NLC 1965, it provides guidelines on how land ownership is acquired, transferred and utilized by individuals or organizations. The NLC outlines procedures for land ownership registration, sales and purchase agreements, and the transfer of ownership.

Moreover, it protects landowners' rights from interference without consent or proper compensation. Another provision in the NLC concerns land use. It sets regulations for the various purposes of land use, including agriculture, residential, commercial, and industrial.

Through land use control, the NLC aims to ensure efficient and integrated land utilization to meet development needs and the welfare of society. Land administration aspects are also addressed in the NLC. It establishes the roles and powers of land-related agencies and bodies, such as district and state land offices. The NLC ensures compliance with procedures and guidelines in land administration, including land partitioning, surveying, and determining land boundaries.

The importance of the NLC in governing land in Malaysia ensures consistency, fairness, and stability in land management. With its comprehensive provisions, the NLC serves as a strong legal foundation to protect landowners' rights, promote sustainable land use, and ensure land development that benefits future generations.

Under the NLC 1965, when a landowner violates any conditions stipulated by the State Authorities in the property title document, their land may be subject to seizure by the State Authorities (Ab Rahim, 2009). Therefore, all landowners are obligated to cultivate the acquired land by developing it according to the land use categories and the explicit conditions specified in the land title.

In the context of land in rural areas, particularly those previously developed with residential houses, being left abandoned, relevant legal provisions can be found in Sections 351 and 352 of the NLC. Section 352 of the NLC confers the

state authorities with authority to undertake actions about reversing land ownership abandoned or left unused by its owner for an uninterrupted period of seven years, during which no evidence of legitimate ownership activities or utilization has been demonstrated.

In such an instance, when land in rural areas remains abandoned for seven consecutive years without any valid ownership activities or proper usage, the state authorities hold the prerogative to initiate measures to reverse land ownership. This reverse implies that the original landowner who neglected the land may forfeit their ownership rights, leading to the land's restoration to the original landholder or other eligible interests. The underlying objective of this legal' provision is to mitigate the escalation of abandoned land in rural areas, an issue that could assume critical significance, particularly in the context of the rapid and widespread rural-to-urban migration phenomenon prevalent in Malaysia.

By implementing such a provision, the NLC endeavours to stimulate active land ownership and productive land utilization, fostering sustainable and integrated development in rural regions.

## 3.2 Existing legal frameworks and procedures to tackle land abandonment

To effectively tackle the intricate matter of land abandonment, it is imperative to establish comprehensive legal frameworks and implement efficient procedures (Joo et al., 2021). In the context of rural-to-urban migration and its consequential effects, adopting a proactive stance towards addressing the issue of abandoned land is imperative to protect land rights (Zhou et al., 2020), promoting sustainable land use and uphold the welfare of impacted communities (Joo et al., 2021). This section provides a current legal mechanism implemented to address land abandonment, with a specific emphasis on

the context of Malaysia.

The NLC 1965 is Malaysia's primary legal framework governing land-related issues. The NLC is the primary legal framework governing land tenure, utilization, and ownership rights nationwide. The aspect mentioned above is pivotal in delineating the entitlements and obligations of individuals who possess the land, guaranteeing the appropriate governance and supervision of land, and settling land conflicts.

One crucial provision within the NLC 1965 that addresses abandoned land issues is Section 351 and 352. This section grants authorities the power to take appropriate action in situations where land is left fallow or abandoned by its owner. This provision aims to prevent the proliferation of abandoned land, which may arise due to the rapid and extensive rural-to-urban migration occurring in Malaysia. According to Section 46 of the NLC 1965, registered land shall revert and vest in the State Authority under the following circumstances (will discuss in subsection 4.1 until 4.3):

(i) after the expiration of the term of ownership (if any);
(ii) upon the issuance of a seizure notice in the gazette due to the proprietor's failure to pay rent (s.100) or breach of conditions (s.129);
(iii) following the death of the proprietor without heirs (s.351) or the proprietor's abandonment of the land (s.352).

Based on the above provisions, when the land is forfeited, it will revert to and become the property of the State Authority, and the previous registered proprietor who held an interest in the land prior to the forfeiture shall lose their ownership rights. The former proprietor is not entitled to any compensation for the land that has been forfeited. This is in contrast to the provisions of the Land Acquisition Act 1960, where the owner is entitled to compensation for the land taken by the State Authority.

### 3.2.1 Expiration of the term of ownership

According to Section 76 NLC 1965, the alienation of State land by the State Authority can be either for a period not exceeding 99 years or in perpetuity, making the registered proprietor the perpetual owner. In consideration of this alienation, the registered proprietor is required to pay land tax and a premium fee. Upon the completion of the alienation process, the registered proprietor acquires an indefeasible title (under Section 92 and Section 340) and the land becomes subject to certain terms and restrictions. For land alienated for a fixed term, ownership of the land will be reverted to the State Authority upon the expiry of that term.

### 3.2.2 Forfeiture under Section 100 & 129 NLC 1965

Sections 100 and 129 NLC 1965 each provide for a distinct forfeiture process to be enforced when notices, in the form of Form 6A or 7B (see fig. 1 and fig. 2), are issued in the gazette concerning the failure of the registered proprietor to pay land tax or the occurrence of a breach of land use conditions by the said registered proprietor.

Fig. 1 and 2 has been developed by the researcher according to the legal action based on forfeiture in section 100 and 129 NLC 1965. Section 100 deals with the non-payment of rent by the registered proprietor, whereby the Collector may serve a notice of seizure in the prescribed Form 6A to demand the outstanding rent to be settled within a specified period. In the event that the rent remains unpaid by the end of the designated period, the land may be forfeited to the State Authority.
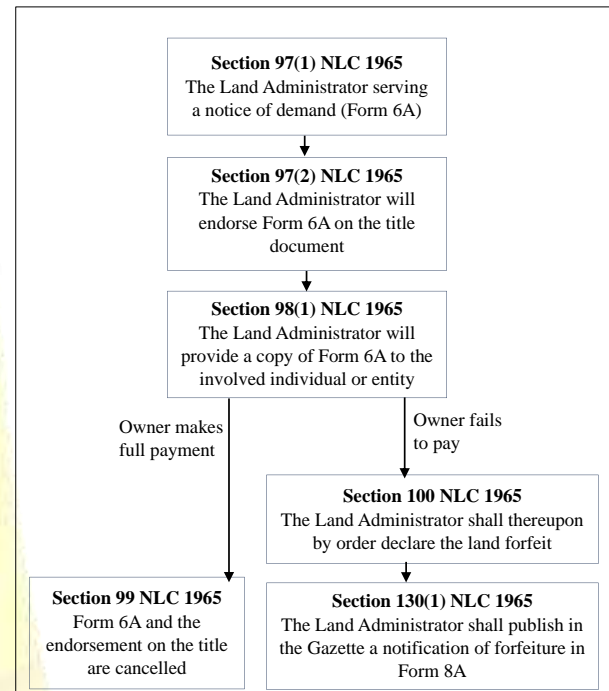


**Figure 1** Flow chart the forfeiture due to failure to pay rent

On the other hand, Section 129 addresses instances of breach of conditions imposed on the land by the State Authority. Upon the occurrence of such a breach, the State Authority may issue a notice of seizure in the prescribed Form 7B, providing an opportunity for the registered proprietor to remedy the breach within a specified timeframe. Failure to rectify the breach within the given deadline may result in the forfeiture of the land to the State Authority.

Both Section 100 and 129 are essential tools for addressing the issue of abandoned land. If the landowner fails to pay the land tax and breach the condition and continues to neglect the settlement of the arrears, the government may proceed with the land forfeiture process in accordance with the provisions of the NLC 1965.

**Section 127(1A) NLC 1965**
The Land Administrator serving a notice

↓

**Section 128 NLC 1965**
The Land Administrator shall serve a notice in Form 7A

↓

**Section 129 NLC 1965**
The Land Administrator shall conduct an investigation whether to continue the forfeiture for breach of condition or not

↓

The Land Administrator shall issue a notice in Form 7B to be served on the proprietor of the land

Owner makes full payment | Owner fails to pay

**Section 129(4) (B) NLC 1965**
The Land Administrator shall give extra time and issue a letter ordering certain actions to be fulfilled

**Section 129(4)(C) NLC 1965**

The Land Administrator shall cancel any note endorsed

Directed by State Authority:
The Land Administrator shall take temporary possession of the land

Not directed by State Authority:
The Land Administrator shall make an order declaring the land forfeit to the State Authority

**Section 130(1) NLC 1965**
The Land Administrator shall publish in the Gazette a notification of forfeiture in Form 8A

**Figure 2** Flow chart the forfeiture due to breach of condition.

### 3.2.3 Reversion under Section 351 & 352 NLC 1965

In the context of abandoned land, Sections 351 and 352 of the NLC 1965 play a crucial role in addressing situations where landowners have either passed away without any heirs or have failed to assert ownership of their registered land. These provisions are essential for the proper administration and management of abandoned land to ensure efficient land utilization and safeguard the interests of the state.

Section 351 of the NLC 1965 pertains to the reversion or forfeiture of land when the registered landowner has passed away without any known heirs (see fig. 3 for the process). The process starts with the Land Administrator receiving a report of the landowner's death. Upon confirmation and the absence of any filed appeals or claims to the estate, the Land Administrator endorses the registration document to reflect the landowner's demise. Subsequently, a notice is issued in the Gazette using Form 23A to declare the landowner's death without any heirs. This provision is crucial in situations where there are no apparent successors to the land, as it allows the state to regain ownership and control of the abandoned land. By doing so, the state can then take necessary actions to ensure the proper utilization and management of the land for public interest or other designated purposes.

**Section 351 NLC 1965**
Reversion land – death of the proprietor without heirs

↓

**Section 351 (1) NLC 1965**
The Land Administrator receiving a report of the landowner's death

↓

The Land Administrator endorses the registration document

Proprietor is still alive

**Section 351 (2) NLC 1965**
Shall cease to have effect and be cancelled accordingly

Original proprietor has died without successors

**Section 351 (3) NLC 1965**
Notice is issued in the Gazette in Form 23A

The land will revert to the State Authority

**Figure 3** Reversion process (section 351)

**Section 352 NLC 1965**
Reversion Land – the proprietor's abandonment of the land

↓

**Section 352 (1) NLC 1965**
The Land Administrator is satisfied that proprietor:
- not effective occupation of the land for past seven years

↓

The Land Administrator endorses the registration document of title

Proprietor not in fact abandoned his title

**Section 352 (2) NLC 1965**
Shall cease to have effect and be cancelled accordingly

Proprietor has abandoned his title

**Section 352 (3) NLC 1965**
Notice is issued in the Gazette in Form 23B

The land will revert to the State Authority

**Figure 4** Reversion process (section 352)

On the other hand, Section 352 of the NLC 1965 deals with the reversion or forfeiture of land in cases of abandonment of rights by the registered landowner (see fig. 4 for the process). This occurs when the Land Administrator is satisfied that the landowner has neither occupied the land nor exercised any acts or deeds asserting ownership for the past seven years. In such cases, the Land Administrator endorses the registration document to indicate the abandonment of rights by the registered landowner. The purpose of this provision is to prevent land from being left unused and unproductive due to neglect by the registered landowner. By enforcing the abandonment of rights, the state can reclaim possession of the abandoned land and subsequently take steps to allocate it to other deserving parties or use it for public purposes.

Both Section 351 and Section 352 are essential tools for addressing the issue of abandoned land under the NLC 1965. They empower the state to reclaim and manage abandoned land effectively, ensuring that it serves the best interests of the public and contributes to the sustainable development and utilization of land resources. By providing a legal framework for the reversion or forfeiture of abandoned land, these provisions play a critical role in promoting efficient land management and supporting the overall objectives of land governance in Malaysia.

## CONCLUSION

In addition to the NLC 1965, other related laws, regulations, and policies at the national and local levels also contribute to the legal landscape concerning abandoned land. Local authorities, such as district land offices, play an integral role in enforcing land-related laws and implementing land-use planning measures to address the issue. These authorities are responsible for identifying abandoned lands, initiating appropriate actions, and coordinating with stakeholders to rehabilitate and utilize the abandoned lands in a sustainable manner.

Despite the existence of legal provisions, there are challenges to effectively tackling land abandonment. One significant challenge lies in identifying and monitoring abandoned lands accurately. The determination of whether land has been genuinely abandoned, especially in cases where landowners may have legitimate reasons for non-use, requires meticulous investigation. Furthermore, the implementation of current legislation may encounter obstacles as a result of constrained resources, administrative inefficiencies, or divergent interests among the various parties involved. In addition, the efficacy of legal interventions is contingent upon the level of public consciousness and community involvement. Educating landowners about their rights and responsibilities concerning land use and abandonment is crucial for fostering compliance with the law. Engaging local communities and stakeholders in the decision-making process regarding abandoned lands can contribute to more sustainable and socially just outcomes.

In conclusion, existing legal frameworks and procedures, particularly the NLC 1965, play a fundamental role in addressing the issue of land abandonment in Malaysia. Through provisions like Sections 351 and 352, the NLC 1965 empowers authorities to take appropriate action in cases of abandoned land.

However, challenges in implementation and the need for community engagement underscore the importance of continuous efforts to improve and enforce legal mechanisms effectively. By ensuring the proper governance of abandoned land, Malaysia can better navigate the impacts of rural-to-urban migration, promote sustainable land use, and foster the well-being of its rural communities.

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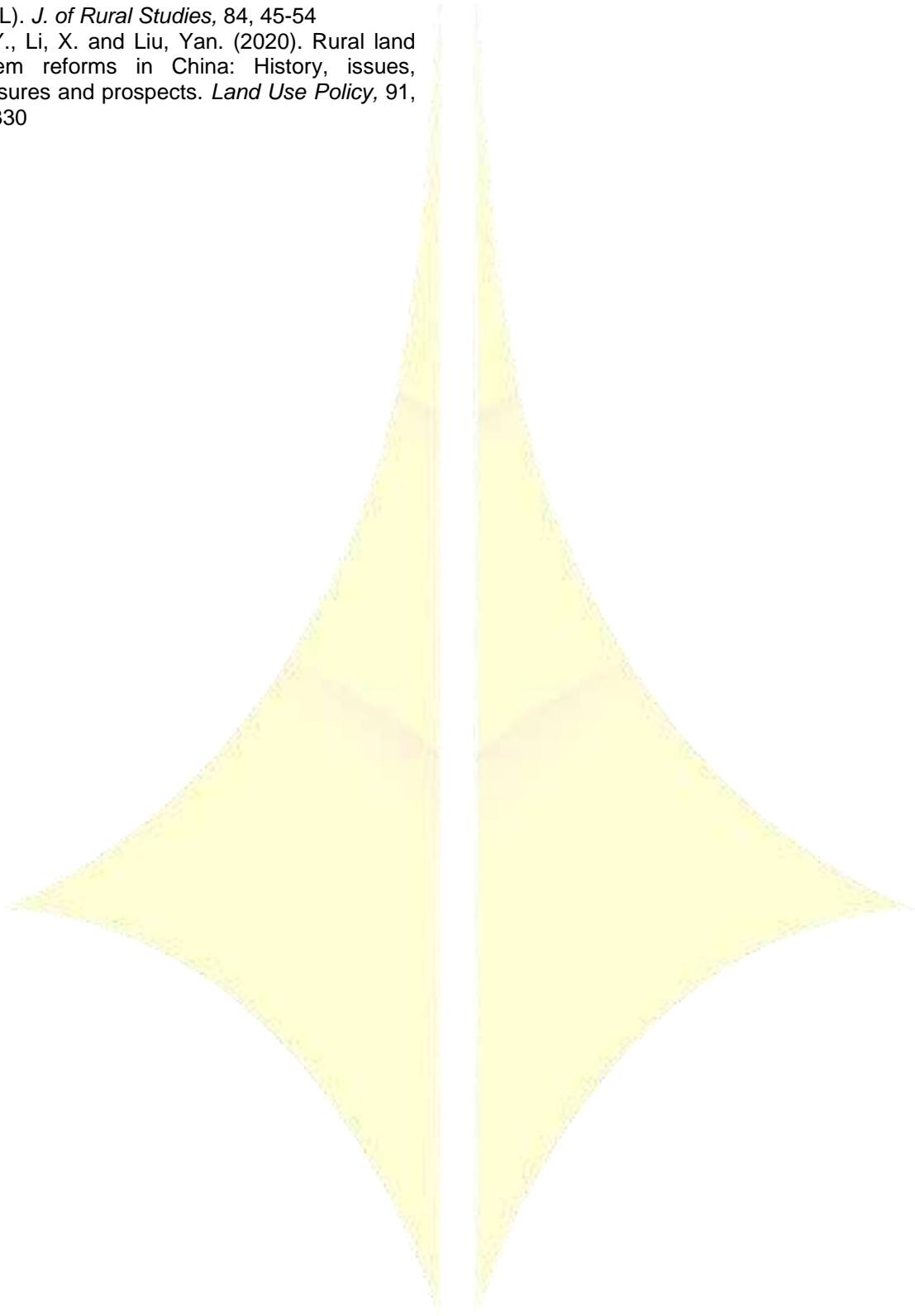
# ARCHITECTURE

# A REVIEW OF SOLUTIONS TO MAXIMIZE THE THERMAL PERFORMANCE OF HIGH-RISE CURTAIN WALL OFFICE WORKING SPACES IN ABUJA.

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## ABSTRACT

Humans spend a more significant proportion of their time indoors than outside, and this tendency is growing as more people adopt metropolitan lifestyles, which are heavily reliant on indoor activities. This is causing buildings' energy needs to rise by an amount never before seen. Researchers across the globe have taken the responsibility of finding a lasting solution to this rise in indoor temperatures, with every finding having its disadvantage on the building occupants or the environment in general. A typical office space of a curtain wall office at the Central Business District in Abuja was selected to investigate the temperature, light intensity and relative humidity via the application of hobo data loggers during the summer of March 2023. The findings from the data loggers indicated that the temperatures recorded throughout the selected month were above international indoor comfort standards for office occupancy. The review aims to outline solutions that could be applied to maximize the thermal performance of high-rise curtain wall office working spaces in Abuja, Nigeria. Specifically, searches were carried out in Scopus, Science Direct and Web of Science journals with search words such as Shading Devices (SD), Vertical Greenery Systems (VGS), Double Skin Glass Facades (DSGF), Phase Change Materials (PCM), and Passive Climate Control Principle (PCCP). Ninety-five journals with 17 conference proceedings were retrieved on the above solutions that enhance thermal performance. The journals were further streamlined to 20 journals of five each on the above solutions related to hot climates and tropical wet and dry climates like Abuja. In conclusion, the study agreed with the existing literature on the capacity of the solutions to optimize the thermal performance of the curtain wall offices. It recommended the application of shading devices on Abuja curtain wall high-rise offices. The review will guide the selection of thermal performance solutions to reduce energy consumption in Abuja curtain wall high-rise offices, making the buildings sustainable and conducive for office occupants.
*Keywords: Thermal Performance, Orientation, Building Occupants, Environment, Climatic Conditions.*

## INTRODUCTION

The building envelope is widely recognized as the optimal initial focus for achieving energy efficiency, with glazing playing a crucial role in attaining satisfactory visual comfort (Kwong, 2020; Rabani et al., 2021). To this end, a continuous scientific investigation exists to reduce the impact of glass on building interior spaces and improve thermal performance for comfort and productivity. Developing energy-efficient systems for incorporation in environmentally friendly buildings necessitates careful consideration of the building's façades during the initial design phase (Chiradeja & Ngaopitakkul, 2019; Rana et al., 2021). This is crucial due to the direct influence of façades on the overall energy consumption, occupant comfort, and operational expenses of the building (GhaffarianHoseini et al., 2016). The utilization of glazing as a proportion of the building envelope is increasing as architects seek to leverage its visual attractiveness (Taleb & Antony, 2020). The proliferation of glazed facades in contemporary architecture has resulted in elevated levels of solar gain within buildings, particularly in regions with warm climates, thereby posing a significant challenge (Ghosh & Neogi, 2018). Glass possesses the remarkable ability to accurately reflect and absorb light, owing to the presence of diverse compositions, layers, shades, thicknesses, and enclosures that influence the transmission of light (Naqash et al., 2021).

Its ability notwithstanding, glass exhibits a prevalent attribute, irrespective of its specific location, purpose, or form, namely its abundant sunlight exposure and high level of transparency. These inherent qualities have facilitated the evolution and broadening of its applications, extending beyond conventional window usage to encompass glazed facades and roofs (Centelles et al., 2021). The ingress of solar heat through glazing systems is a significant factor contributing to the escalation of indoor temperatures, thereby necessitating higher levels of cooling during periods of extreme heat. The design of glass buildings and facades in hot, arid regions needs to be more informed by considerations of the local climate and architectural heritage (Alwetaishi, 2019). The phenomenon above results in elevated energy consumption for regulating the indoor temperature of such structures, as well as the emergence of glass blocks that deviate from the established architectural character of the nation (Sayed & Fikry, 2019). The advantages of having a larger glazing area in humid and hot regions outweigh those in hot and dry climates due to the limited indoor temperature fluctuations experienced throughout the year and between day and night (Alwetaishi, 2019).

The thermal performance of the interior spaces within an office building is a critical determinant of occupant comfort, productivity, and energy conservation capabilities (Birkha Mohd Ali et al., 2021; Hwang & Chen, 2022; Mansor & Sheau-Ting, 2022). The strain placed on the HVAC system may increase due to the infiltration of warm air from the external environment, thereby leading to a direct augmentation of the overall energy consumption of the building. The building sector is responsible for the highest use of energy on a global scale. Hence, enhancing energy efficiency in building interiors can mitigate energy consumption within the construction sector (Chi et al., 2022; Dervishi et al., 2022; Dino & Meral Akgül, 2019; Elgheriani & Cody, 2019; Jin et al., 2022). The analysis indicated that integrating construction materials and technologies presents a highly efficient approach for mitigating heat gains via conduction (Manu et al., 2019). The thermal performance of a system is influenced by various factors, including climatic conditions, design considerations,

material properties, and patterns of usage (Jha, 2020). Neglecting to consider the consequences of climate change may lead to a significant rise in the need for cooling systems in buildings while simultaneously reducing the demand for heating. The modifications above significantly impact the comprehensive evaluation of buildings' global warming potential and cost assessments throughout their lifespan (Tamer et al., 2022). In geographical areas with ample solar radiation and high temperatures, such as those found in Mediterranean climates, it is crucial to give precedence to the development of building facades that exhibit a low overall solar factor. Effectively managing the demand for air conditioning is essential in this context (Planas et al., 2018). One of the productive strategies for mitigating energy losses in buildings entails adopting thermal insulation techniques that facilitate enhanced thermal efficiency (Ustaoglu et al., 2020). The solar radiation from the sun to the earth in hot climates is high, and it is necessary to check its effects while harnessing the benefits of solar radiation (Tong et al., 2021).

The physical environment of an office working space has varying degrees of influence on employees' happiness, productivity, and overall well-being (Agha-Hossein et al., 2013). A structure that demonstrates exceptional performance or encourages a sustainable environment possesses the capacity to alleviate absenteeism, augment occupant productivity, and cultivate employee well-being (Al Horr et al., 2016). To this end, according to the guidelines set forth by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standard 55, it is recommended that the Predicted Mean Vote (PMV) falls within the range of -0.5 to +0.5. Any PMV value exceeding this range would indicate overheating (Alnuaimi et al., 2022). Based on the guidelines established by ANSI/ASHRAE 62.1, it is advisable to maintain indoor carbon dioxide ($CO_2$) concentrations at levels below 700 parts per million (ppm). The thermal characteristics of an enclosed space contribute to determining the concentration of carbon dioxide ($CO_2$) within the area (Kajjoba et al., 2021). Establishing indoor conditions relies on adopting an acknowledged thermal comfort standard, such as ISO 7730, ASHRAE Standard 55, or EN 16798-1:2019 (Hermawan et al., 2020). The influence of thermal dissatisfaction is more noticeable in cool or cold environments than in warm or hot climates. In contrast, improving thermal satisfaction positively impacts productivity (Kang et al., 2017).

Different attempts have been made to define high-rise buildings based on the codes that back the built environments of different countries. Any building that is 23-30m tall or has floors more than seven is usually referred to a high-rise building. In UAE, the average number of floors considered high-rise is 30 floors. High-rise are structures that are more than 23m (7–10 floors). High-rise structures are divided into four categories based on their major use: office, hotel, residential and mixed-use (Ezeh et al., 2022). Space availability and rise in urbanization are the major factors contributing to the development of high-rise buildings in most cities of the world. Where land is a constraint, developers choose to go vertically to accommodate the continuous rising rising population in cities across the globe necessity for a specific physical form, the concentration of activity, the proximity to crucial amenities for large numbers of people, and being a more sustainable type of development can all be used to illustrate the special qualities that tall buildings require (Huang et al., 2020).

Retrofitting has become the most recent alternative to solving environmental challenges related to building envelopes especially glass. The implementation of vertical shading devices at a 0° angle on

structures with natural ventilation leads to enhanced airflow compared to applying fins at a 90° angle (Alwetaishi et al., 2021). The passive methods approach has gained relevance due to the prevailing trend in energy consumption in buildings, owing to its ability for energy efficiency (Vázquez-Torres et al., 2023). The implementation of double-skin facades in office buildings has proven improved indoor conditions and mitigating the drawbacks associated with mechanical ventilation. This is primarily achieved through the utilization of natural ventilation, which not only meets comfort requirements but also aids in reducing solar heat gain (Reza & Suleiman, 2021). Phase change materials (PCMs) possess a higher energy storage capacity in comparison to typical building materials such as concrete, tiles, and cement plaster (Rathore et al., 2022). Vertical greening systems (VGS) have a beneficial impact on the performance of building envelopes, particularly during cooling periods before its recognition as the Federal Capital Territory of Nigeria in 1991. Population growth, inadequate land for expansion due to water bodies in Lagos and the need to centralize the Federal Capital Territory necessitated the relocation of the FCT to Abuja in 1991. According to the Koppen climate classification, Abuja, located in the tropics, has a tropical wet and dry climate characterized by three distinct weather types throughout the year. The region experiences a warm and humid rainy season and a highly arid dry season, with daytime temperatures ranging between 28°C to 38°C during the dry season, while the overnight temperature can be as low as 22 °C (Mashi et al., 2022). The onset of the rainy season commences in April and concludes in October. A short harmattan period is attributed to the prevailing northeast trade wind, characterized mainly by dust haze and aridity. This period commences in November and extends until January or February. The Federal Capital Territory's (FCT) geographical features, including its topography, elevated elevations, and undulating terrain, moderate the local meteorological conditions within the region. The precipitation patterns in the Federal Capital Territory (FCT) are influenced by its geographical position on the windward side of the Jos Plateau and its classification as an area where air masses ascend. The yearly precipitation amount falls between 1100–1600 mm (Mahmoud et al., 2016).

Abuja is included in the global trend of glass architecture in the construction of high-rise offices, which has become the most applied building envelope material used for offices in cities around the world (Homod et al., 2021). With its urbanization and the use of glass in office buildings, which require high energy for cooling (Aguilera-Benito et al., 2021). Consequent to the challenges glass poses to building interiors, especially in hot and tropical wet climates, several researches are available in the literature on the thermal performance of residential buildings, institutional buildings, educational buildings and office buildings, but little has been done on the thermal performance of high-rise curtain wall offices in Abuja considering the climatic conditions. Through a review of literature in the related study area and similar climatic conditions as that of Abuja, the article aims to outline solutions that could be applied to maximize the thermal performance of high-rise curtain wall office working spaces in Abuja which will guide the building stakeholders in the design and selection of solutions to optimize the thermal performance of curtain wall offices in Abuja.

## MATERIALS AND METHODS

### Study Office Temperature

As part of ongoing research to investigate the effects of curtain wall retrofitting on the thermal performance of working spaces in Abuja high-rise offices, hobo data loggers

were placed in different orientations of a selected eight-floor curtain wall office within the Central Business District, Abuja. The data loggers were placed in a typical office on the fourth floor at a work plane of 900mm from the finished floor level in March 2023, the hottest summer month in Abuja.

**Table 1.** Temperature, Illuminance and RH data of study office in various orientations.

| Test Orientation | North Orientation | | | East Orientation | | | South Orientation | | | West Orientation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dates/Time | Illuminance (lux) | Temperature (t) | Relative Humidity (%) | Illuminance (lux) | Temperature (t) | Relative humidity (%) | Illuminance (lux) | Temperature (t) | Relative humidity (%) | Illuminance (lux) | Temperature (t) | Relative humidity (%) |
| 3/1/23 8:00 | 443.4 | 33.2 | 54.0 | 1937.0 | 38.2 | 40.9 | 439.5 | 34.6 | 49.9 | 305.2 | 34.4 | 50.6 |
| 3/1/23 9:00 | 526.2 | 33.6 | 54.3 | 2732.7 | 39.0 | 41.1 | 585.0 | 35.0 | 51.0 | 373.5 | 34.6 | 52.1 |
| 3/1/23 10:00 | 507.6 | 34.2 | 55.9 | 2421.5 | 39.6 | 42.4 | 651.8 | 35.4 | 52.9 | 397.9 | 35.0 | 54.1 |
| 3/1/23 11:00 | 493.2 | 34.9 | 54.9 | 1589.5 | 40.4 | 41.3 | 712.3 | 36.3 | 51.3 | 421.4 | 35.8 | 52.7 |
| 3/1/23 12:00 | 478.4 | 35.3 | 53.3 | 920.9 | 40.7 | 40.1 | 764.5 | 36.9 | 48.9 | 457.4 | 36.2 | 50.9 |
| 3/1/23 13:00 | 443.7 | 35.5 | 49.0 | 560.3 | 40.6 | 37.2 | 775.7 | 37.2 | 44.7 | 515.0 | 36.4 | 46.7 |
| 3/1/23 14:00 | 375.7 | 35.7 | 44.9 | 387.9 | 40.8 | 34.2 | 701.0 | 37.5 | 40.8 | 709.4 | 36.9 | 42.3 |
| 3/1/23 15:00 | 294.4 | 36.1 | 42.7 | 278.2 | 41.1 | 32.6 | 562.9 | 37.7 | 39.1 | 906.0 | 37.3 | 40.0 |
| 3/1/23 16:00 | 211.4 | 36.4 | 40.4 | 191.3 | 41.4 | 30.7 | 395.0 | 37.8 | 37.2 | 945.6 | 37.6 | 37.7 |
| 3/1/23 17:00 | 104.2 | 36.7 | 38.6 | 88.4 | 41.7 | 29.4 | 175.9 | 38.2 | 35.5 | 494.5 | 37.6 | 36.7 |
| 3/1/23 18:00 | 12.4 | 37.0 | 36.4 | 12.4 | 41.9 | 27.9 | 12.4 | 38.6 | 33.3 | 12.4 | 38.3 | 33.9 |
| 3/1/23 19:00 | 0.0 | 37.1 | 37.0 | 0.0 | 41.9 | 28.6 | 0.0 | 38.7 | 34.0 | 0.0 | 38.4 | 34.5 |

For the study, results were obtained from 1 AM to 11 PM on 3/1/2023 at hourly intervals (Jin et al., 2022; Yoon et al., 2023).

Table 1 shows the temperature, relative humidity and illuminance level of the typical test office for the study. From the table, the values in red colour represents the temperature recorded within the office hours of 8 AM to 5 PM on 3/1/2023 as part of the entire data for the month obtained during in March. Despite the difference in indoor temperatures of the office based on various orientations,99% of the temperature readings are deemed above comfort ranges according to global performance and comfort standards from the start of the working hours of the day till the end of active office hours. The raw results obtained necessitated this review to suggest a solution capable of mitigating the current comfort level, thereby optimizing the thermal performance of the office working spaces.

**Relevant Literatures**

This review employs a systematic approach to gather and evaluate relevant research on the utilization of Shading Devices (SD), Vertical Greenery Systems (VGS), Double Skin Glass Facades (DSGF), Phase Change Materials (PCM) and Passive Climate Control Principle (PCCP) in office buildings, with a focus on climatic conditions of the areas of applications and their orientation. A comprehensive search of scholarly databases and pertinent publications was

conducted to identify studies and research articles relevant to the topics under consideration. The criteria for inclusion were established based on the foundational elements of the above principles and solutions about thermal performance. The selected research underwent thorough examination and analysis regarding its key findings, methodological strategies, and conclusions. Ninety-five journals from Scopus, ScienceDirect and Web of Science were searched, with 17 conference proceedings centred on applying Shading Devices, Vertical Greenery Systems, Double Glass Facades, Phase Change Materials, and Passive Climate Control Principles. They were further streamlined to 20 journals (five each on the solutions to thermal performance) that specifically address hot climates and tropical wet and dry climates.

## REVIEW OF THERMAL PERFORMANCE SOLUTIONS

### Shading Devices

Evangelisti et al., (2020) investigated the energy efficiency of a building shading device by overhauling a renovated building to prioritize optimal performance from both passive and active standpoints. The authors conducted a study to examine the effects of external shading systems using on-site measurements. Additionally, they put forth a novel index for evaluating the efficacy of the shading mechanism.

The efficacy of the shading device in reducing the external surface temperature of glazing was evaluated through a combination of numerical simulations and empirical measurements, thereby assessing the performance of the index.

The temperatures observed on the external surface by the authors are found to be correlated with the heat transfer mechanism near the wall. During the summer, the outer surface temperatures decrease when shielded, compared to when they are not covered. According to the authors, this phenomenon can be attributed to the influence of solar radiation. Figure 1 illustrates the relationship between the TRI trend and the ratio of external surface temperatures. The identified range of validity pertains to the positive surface temperature ratios, wherein the green area signifies TRI values below 100%. In the region situated to the right of the dark, bold dotted line, the surface temperature ratios yield inconsistent Thermal Response Index (TRI) values, surpassing 100% or descending below 0%. The investigation by the authors obtained the following findings:

a) The findings from the in-situ campaign indicate that the sun's shielding system successfully decreases the amount of thermal energy entering the building by 38.7% during the summer months. This outcome significantly contributes to the conservation of power within the building. On the other hand, the impact of shading during the winter season was negligible.

b) The Total Reduction Index (TRI) offers a valuable means of obtaining brief data regarding the effectiveness of a shading system in isolation during the summer season. It can also serve as a tool for providing information on the extent of solar gains reduction during the winter season.
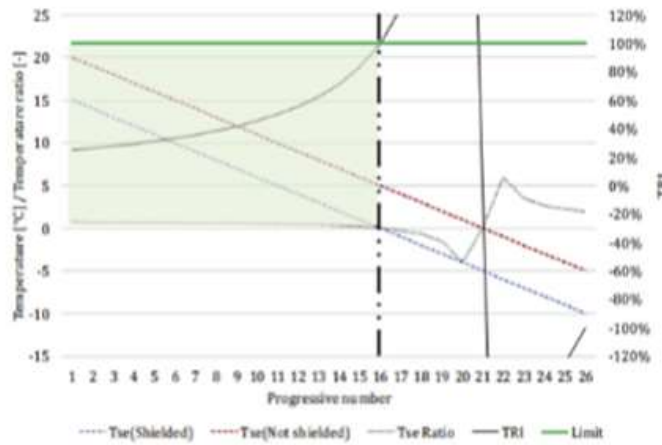
**Figure 1**. Relationship between TRI values and external surface temperature ratios (Evangelisti et al., 2020).

The study by Rana et al., (2021) aimed to examine the influence of shading systems on the energy consumption of commercial buildings situated in a subtropical climate. The authors' research primarily focuses on identifying shading device parameters that exhibit energy efficiency and cost-effectiveness within the specific climatic conditions of Bangladesh.

**Table 2.** Energy simulation boundary conditions were used in the study (Rana et al., 2021).

| Building Characteristics | Description |
|---|---|
| HVAC system | Residential |
| Thermostat set point | For cooling -20°C |
| | Supply cooled air -15.55°C |
| Condition type Infiltration | Only cooling |
| | 0.0336 cfm/square foot through the exterior wall |
| | 0.010 cfm/square foot through the exterior roof |
| Thermal conductivity of brick wall | 0.4167 Btu/h-ft- $^0$F |
| Thermal conductivity of concrete roof | 1.014 Btu/h-ft- $^0$F |
| U-value of centre glass of window | 1.11 W/m²K |
| U-value of aluminium frame + glass | 1.21 W/m²K |
| Solar heat gain coefficient of window glasses | 0.86 |
| Lighting control | Switch on/off |
| Shading device | No shading |
| Occupancy schedule | 9 AM to 5PM (5 days per week) |
| Lighting intensity | 1.50 Watt/square foot |
| Office equiptment loads intensity | 2.0 Watt/square foot for common office area |
| | 0.5 Watt/square foot for miscellaneous area |
| Sensible heat gain | 60 Watt (205 BTU/h) per person |
| Latent heat gain | 50 Watt (170 BTU/h) per person |

The achievement was accomplished by implementing an extensive energy simulation using the eQUEST 3.65 software for a prototype office building. The authors thoroughly examined pertinent scholarly works to explore the influence of shading systems on the energy consumption of buildings across various geographical regions. They developed an energy model by integrating design assumptions and boundary conditions to create a standardized energy model suited explicitly for subtropical climates. Table 2 presents the boundary conditions that are necessary for conducting energy simulations. These conditions encompass a range of factors, including the number of occupants, usage schedule, illumination schedule, office supplies schedule, perceived heat gain, infrared heat gain, and other distinct

properties specific to each zone.

The authors performed a rudimentary linear regression analysis to investigate the association between the increase in overhang heights and the annual temperature and overall load in different orientations. The study centred its research on the independent variable of overhang depth, while the dependent variables of yearly temperature and overall load were considered. When the overall height of the fins in the south direction increases by 1 foot (0.30 m), the building's yearly overall load will decline by 438.93 kWh.

The authors have derived several findings from their study by investigating the impact of shading systems on energy consumption in commercial buildings in a subtropical climate. Some of these are:

a) In any orientation of the building, it is recommended that the optimum overhang and fin height be set at half of the window height.

b) Optimal efficiency can be achieved by implementing larger fin and overhang heights in the south and west orientations of a building, as compared to other directions.

c) The utilization of fin shading devices in both west and east orientations resulted in a more significant reduction in cooling load compared to the implementation of overhangs. Maintaining a more considerable fin height in the west and east exposures is expected to yield enhanced effectiveness. Implementing overhangs in the southern orientation delivers a more significant reduction in cooling load compared to

implementing fins in the same direction.

In their research, Santolini et al., (2022) undertook a study examining the effects of shading screens on the climatic conditions of greenhouses and glazed facade structures. The research encompassed the introduction of a novel computational fluid dynamics (CFD) methodology and an innovative technique for assessing indoor climate. This study aimed to analyze the distribution of temperature and airflow within a ventilated three-span glazed greenhouse, considering the impact of radiation from the sun.

The authors analyzed the impact of three shading devices on the indoor conditions of the efficient area of a greenhouse. The objective was to identify the most suitable screen position and permeability based on the prevailing requirements of the environment, specifically sunlight and wind directions, regarding the orientation and placement of the windows.

Figure 2a illustrates variation values exceeding 300 W/m2 within a single hour. Solar radiation notably impacts airflow distribution within a naturally ventilated greenhouse. Therefore, relying solely on the average value may oversimplify the situation. The simulations utilized the average direct solar radiation over 15 minutes. Figure 2b compares the velocity measurements conducted within the greenhouse and the corresponding values obtained through computational fluid dynamics (CFD) simulation across twenty-four distinct positions. Figure 7b exhibits a high level of concordance between the numerical outcomes and the experimental observations, as evidenced by the shallow root mean square error (RMSE) of 0.14 m/s calculated across the entire dataset.
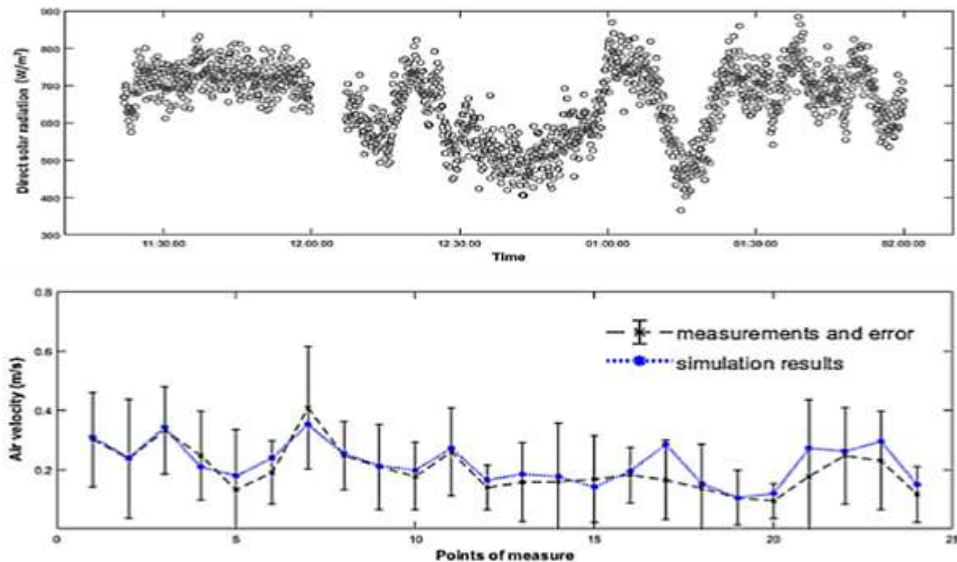
**Figure 2.** (a) sun radiation by pyranometer (b) comparison between the velocity measurements conducted within the greenhouse (Santolini et al., 2022).

At the end of their study to determine the impact of shading screens on microclimates of greenhouses and glass facades buildings, the authors arrived conclusively as follows:

a) Screens that have low permeability provide the most effective temperature mitigation while ensuring a consistent temperature distribution above the crops. Nevertheless, screens with excellent permeability perform better when the wind directly impacts the wall.

b) an optimal screen should be selected by considering the prevailing wind directions regarding the orientation and placement of windows within the building.

c) Implementing shading facades in glass envelope structures enables mitigating solar radiation impact during summer periods. Simultaneously, the implementation of screens has the potential to decrease air velocity, thereby enhancing the evenness of temperature distribution within the indoor environment.

Mesloub et al., (2020) employed a thorough numerical parametric simulation approach, utilizing EnergyPlus and Diva-for-Rhino simulation tools, to assess the energy and daylighting efficiency of semitransparent photovoltaic (STPV) windows integrated with interior light shelves (ILS) in fully glazed open-office facades across various climatic conditions. The authors conducted simulations of various solar thermal photovoltaic (STPV) configurations in four distinct climatic regions. The purpose was to examine how different latitudes and climatic conditions affect the optimal design of these integrated systems. The Meteonorm meteorological database was utilized to obtain data for the subtropical desert climate of Riyadh. Additionally, the Typical Meteorological Year (TMY) files of London, Algiers, and Kuala Lumpur were employed to gather information about the marine west coast (temperate), Mediterranean, and tropical rainforest climates, respectively. Table 3 presents the geographical locations and corresponding climatic conditions of each zone used in the study, as determined by the Koppen Climate Classification.

**Table 3.** Climatic Conditions of various cities were used in the research (Mesloub et al., 2020).

| Cities (climate) | Latitude | longitude | Average air temperature in winter and summer (⁰C) | Annual average solar irradiance (kWh/m²) | Sky condition | External illuminance (Klx) |
|---|---|---|---|---|---|---|
| Riyadh (subtropical desert climate) | 24.43⁰N | 46.43⁰E | 14.4-36.1 | 2200 | Clear | 19 to 35 |
| London (marine west coast climate) "Cfb" | 51.09⁰N | 0.11⁰W | 4.3-17.3 | 1000 | Overcast | 03 to 20 |
| Kuala Lumpur (tropical rainforest) "Af" | 03.07⁰N | 101.33⁰E | 27.2-28.3 | 1600 | Intermediate | 18 to 23 |
| Algiers Mediterranean "Csa" | 36.43⁰N | 3.15⁰E | 11.1-25.6 | 1900 | Clear-overcast | 10 to 36 |

The results of the evaluation carried out by Mesloub et al., (2020) revealed the following:

a) The optimal configuration of the south-facing facade, incorporating a nonuniform front, involved clear glazing windows with 50% coverage of STPV10 combined with ILS. This design yielded significant energy savings of 76%, 83%, 65%, and 70% in Riyadh, London, Kuala Lumpur, and Algiers, respectively.

b) The utilization of solar thermal photovoltaic (STPV) windows and integrated lighting systems (ILS) presents a multitude of advantages in terms of reducing the carbon footprint within buildings. Additionally, it fosters the development of design strategies that aim to harmonize the incorporation of STPV windows and ILS with enhancements in energy efficiency and the luminous environment.

Koç & Maçka Kalfa, (2021) conducted a study to assess the impact of shading devices on the energy performance of office buildings in Mediterranean climate regions. The parameters evaluated included the type of shading device, its orientation, the type of glazing used, the window-to-wall ratio (WWR), the depth of the shading device, and its slope.

The findings derived from the primary energy consumption data of 1485 scenarios, as analyzed using the DesignBuilder software, indicated that:

a) Using sustainable design (SD) has proven to be highly productive in enhancing the energy efficiency of buildings in Mediterranean climate regions.

b) The optimal outcomes achieved for each shading device category resulted in a reduction in cooling energy usage ranging from 37% to 49% compared to the absence of shading, utilizing high-performance glazing. Similarly, compared to the lack of staining with low-performance glazing, the reduction in cooling energy usage ranged from 73% to 78%.

The analysis of various parameters about shading devices revealed their significant efficacy in enhancing the energy performance of buildings in Mediterranean climate regions. Specifically, the implementation of shading devices resulted in a substantial reduction in cooling energy consumption, reaching up to 78% when compared to the absence of shading (Koç & Maçka Kalfa, 2021).

**Phase Change Materials**

Gopinath et al., (2022) conducted a

comprehensive quantitative analysis to examine the utilization of phase change material (PCM) in building walls in the context of climatic conditions in Chennai. The investigation by the authors employed n-Octadecane (C18H38), Calcium chloride hexahydrate (CaCl2Á6H2O), and Sodium carbonate decahydrate (Na2 CO3Á10H2O) phase change materials (PCMs) for the iterative melting and freezing thermal cycles. The analysis highlighted the following findings:

a)      Incorporating PCM in the walls of a building resulted in a reduction of energy transfer into the cooling chamber, and this reduction in energy transmission could lead to a decrease in energy consumption to cool the room.

b)      The utilization of Phase Change Material (PCM) within the construction of building envelopes has demonstrated efficacy in storing thermal energy and enhancing indoor thermal performance.

c)      Phase change materials (PCMs) can store significantly more energy than conventional building materials. Furthermore, PCMs exhibit versatility in their availability across a broad spectrum of temperatures, rendering them suitable for application in diverse climatic conditions and seasons.

Hart et al., (2019) conducted an assessment of the thermal efficiency and potential annual energy implications associated with retrofit thin-glass triple-pane glazing in residential buildings in the United States. The initial step taken by the paper's authors involved the establishment of a clear definition for the attributes and effectiveness of prevailing residential windows. This was accomplished by comprehensively analyzing the National Fenestration Rating Council (NFRC) Certified Products Directory (CPD). Subsequently, the authors ascertained the prospective influence on thermal performance from substituting conventional glazing with triple-pane glazing composed of thin glass. In addition, the authors defined the gap between glass panes through the analysis of CPD data on typical window construction. Figure 3 displays a histogram representing the gap widths observed in double-hung 2P-LSG products. The findings indicate that the average and middle gap widths are approximately 0.50 inches. Therefore, the width of 0.50 inches is utilized in the subsequent analysis. CDP data for fixed window gap width was not available. Thus, the authors for fixed windows also incorporate the results obtained from the double-hung window
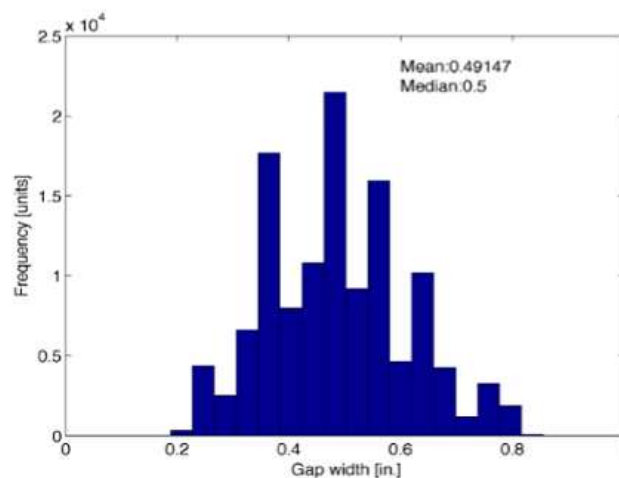


**Figure 3.** The distribution of gap width between glass for 2P-LSG double-hung products in the NFRC-certified products directory (CPD) (Hart et al., 2019).

Figure 4 shows the variations in the mean thermal transmittance of conventional double-hung and fixed windows under different experimental conditions. These conditions include the application of foam filling, low-emissivity (Low-E) coating with varying emissivity levels (0.07, 0.04, and 0.02), and thin-triple glazing. Additionally, the authors examined the impact of different spacer types (aluminium bar, U-type, and foam). The variations in average values demonstrated the sensitivity of each variable. The authors utilized all of these techniques, and their findings indicated that these techniques could decrease the U-factors by a maximum of 0.03 BTU hr−1 ft−2 °F−1. This suggests that it is possible to attain U-factors below 0.14 for fixed windows and 0.18 for double-hung windows without significantly altering the frames presently accessible in the market.
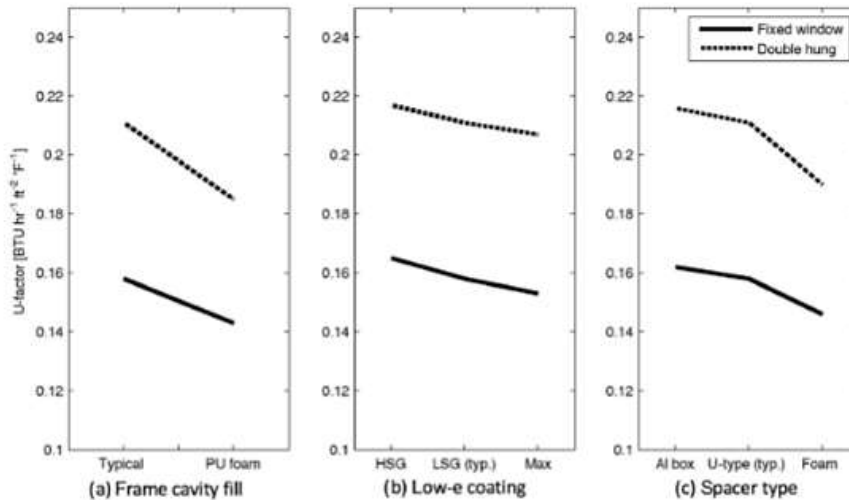


**Figure 4.** Fluctuations in the average thermal transmittance of standard double-hung and fixed windows when subjected (Hart et al., 2019).

**Table 4**. Uncertainty analysis for all studied wall states (Fox et al., 2022)

| Wall State | Final moving average calculated U-Value (W/m2K) | U-value uncertainty ± (W/m2K) | Percentage uncertainty ± from calculated (%) |
|---|---|---|---|
| Masonry cavity wall with living wall façade | 0.77 | 0.07 | 8.70% |
| Masonry cavity wall without living wall façade | 1.12 | 0.10 | 8.71% |

The findings derived from the study include:

a) The utilization of thin-triple glazing as a substitute for conventional low-emissivity (Low-E) windows in residential structures presents a noteworthy opportunity for energy conservation. Specifically, in regions with a predominant need for heating, such as Minneapolis, MN, the potential energy savings amount to 16%. As exemplified by Washington, DC, the energy savings potential is 12% in mixed climates. Lastly, in environments with more prevalent cooling demands, such as Houston, TX, the energy savings potential is approximately 7%.

b) Implementing a thin-glass triple-pane design for window glazing presents a substantial potential for achieving energy efficiency in buildings.

Abdul Mujeebu & Ashraf, (2020) Their study comprehensively analyzed the impact of location and deadband on the energy effectiveness and economic feasibility of nano fine silica aerogel (nano gel) glass in a multistorey office block in Saudi Arabia. The authors conducted energy simulation using the Ecotect (2011) software to accomplish the research objective. Subsequently, a comparative examination was undertaken to evaluate the energy effectiveness of nano gel glazing about double-glazed windows in two distinct scenarios: (i) with both well-insulated wall and roof, along with double-glazed windows, and (ii) with both well-insulated wall and roof, along with nano gel glazing.

Shaik et al., (2022) presented an extensive compilation of potential solutions and technologies designed to improve

buildings' energy efficiency. To accomplish the study's objective, Shaik et al., (2022) investigated the impact of various glass retrofits on the cost savings associated with air conditioning in an office building in a hot and arid region of India. The authors analyzed the solar transparency, diurnal

lighting factor, colour-making metrics, and the potential cost savings related to fourteen different glazing system retrofits. It was determined that:

a) An optimal glazing system is imperative to enhance the thermal and visual comfort within building interiors.
b) The analyzed retrofit glazing systems possess a colour rendering index exceeding 80, indicating satisfactory lighting quality.
c) Glazing systems characterized by low visible light transmission (VLT) values exhibit considerable potential and novelty in the context of thermal enhancement.

The thermal effects of living wall systems on existing structures were investigated by

The investigation yielded the following outcomes:

a) There is a strong correlation between the potential for energy efficiency and the efficiency of nano gel glazing, which is consistent with cooling temperatures during the

b) day (CDD) and outside dry bulb temperatures (DBT).

c) The application of nano gel glazing provides significant benefits in areas with elevated dry bulb temperatures (DBT) and cooling daytime temperatures (CDD), especially in regions where cooling requirements surpass heating requirements.

Fox et al., (2022). To evaluate the difference in thermal transmission between a pre-existing cavity wall enhanced with an external layer of living wall vegetation and a wall without such vegetation, the authors installed two sets of heat flux sensors to measure the thermal conductivity of the two distinct wall locations. The results presented in Table 4 demonstrate that the uncertainty in the calculated U-value results for each wall state, as determined by the final moving average, did not surpass ±0.10W/m2K. The study yielded an average temperature difference of 8.26 Kelvin.

Findings from the study by (Fox et al., 2022) are:

a) Incorporating a living wall system onto the exterior surface of an uninsulated cavity masonry wall can significantly mitigate heat losses by approximately 31.4% and minimize variations in heat flux throughout the day.
b) Living wall systems present a feasible approach to enhance the thermal efficiency of preexisting structures, concurrently offering supplementary advantages such as

heightened biodiversity, sound absorption capabilities, and diminished air pollution levels.

## Double Skin Facades

In a study by Nabil & Mahri (2022), the authors utilized an implicit finite difference method to calculate the transmission loads across walls and window glasses. This computational approach considered various factors, including building orientation, wall insulation, and the specific type of glazing material. The meteorological station data furnished with the ambient air temperatures for determining the transmissivity, reflectivity, and absorptivity values for single and double glasses using the respective properties of the glasses was obtained by Nabil & Mahri (2022) for the study.

The authors identified the following points as the conclusions derived from his study:

a) The augmentation of the glazing area in the context of single glazing results in the imposition of supplementary heating and cooling loads.
b) When comparing single glazing to double glazing, it is evident that the latter offers a substantial decrease in

heating load for buildings of all orientations.
c) The choice of glazing type and its surface area substantially influence the thermal efficiency of buildings.

The study by Tao et al. (2021) investigated the effectiveness of a double-skin façade that relies on natural ventilation in buildings. This was accomplished by employing a numerical model validated through experimental data. The primary objective was to analyze the airflow patterns within the naturally ventilated double-skin façade (NVDSF) and the associated room, considering the combined effects of radiation and natural convection. Figure 5a depicts the geometric configuration and meshing of the computational model used by Tao et al. (2021). The model encompasses a domain, as illustrated in Figure 5b, comprising a Non-Ventilated Double Skin Facade (NVDSF) and an adjoining room with dimensions of 4 metres in length, 4 metres in width, and 3 metres in height. The inlet of the natural ventilation and daylighting system (NVDSF) is located at the lower section of the inner façade. At the same time, the outlet is positioned at the upper section of the outer façade. The dimensions of these openings may vary depending on different scenarios.
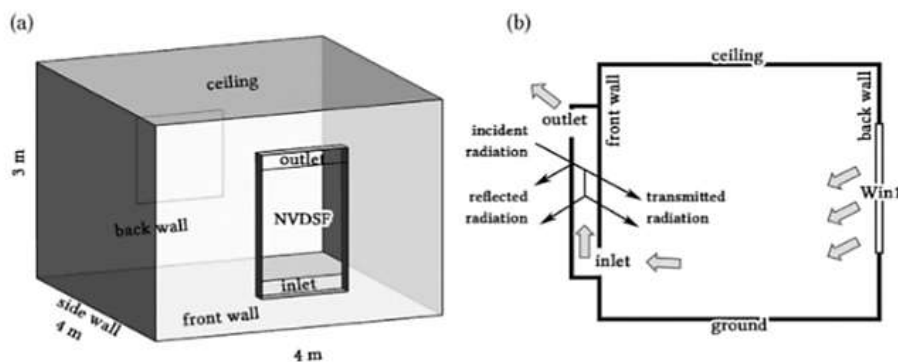


**Figure 5**. (a) Dimensions of the model in 3D view (b) Diagram of the room (Tao, Zhang, Zhang, et al., 2021).

Tao et al. (2021) identified the following from their study:

a) Implementing a naturally

ventilated double skin façade (NVDSF) holds significant promise for energy conservation, as it facilitates the circulation of natural

indoor airflow without incurring any operational expenses.

b) The ventilation rate of an NVDSF is most significantly influenced by the gap depth and vent sizes, which present complex implications. Insufficient dimensions can dramatically hinder the ventilation process, as exemplified by more than 16% and 26% reductions for every 0.1-metre decrease in gap depth and vent height, respectively.

The effectiveness of prefabricated double-skin façades (DSFs) in improving indoor thermal comfort in office buildings in Abuja, Nigeria, was investigated through thermal testing using Autodesk Ecotect analysis software by Reza & Suleiman (2021). The study aimed to assess the efficacy of prefabricated double-skin façade (DSF) systems in improving the indoor thermal comfort conditions of office buildings in Abuja, Nigeria. To accomplish this objective, the authors opted for two structures positioned where their elongated sides aligned along the North-South Axis. In contrast, their shorter sides were aligned along the East-West Axis.

The temperature of the building was assessed using Autodesk Ecotect

Analysis 2011, both in its original state without any form of double-skin façade (DSF) and with different variations of DSF. The authors concluded that:

a) The findings indicate that DSF exhibits promise in enhancing the thermal environment of workplaces and mitigating energy consumption.

b) Implementing double-skin facades in office structures in Abuja, Nigeria, has proven effective in achieving comfortable indoor conditions while mitigating solar heat gain. This approach utilizes natural ventilation as an alternative to mechanical ventilation, thereby addressing the limitations associated with the latter.

c) Dynamic Simulation of Facades (DSF) can rehabilitate existing buildings to enhance their thermal environment and energy efficiency.

Italos et al. (2022) examined the energy efficiency of pre-existing residential apartments in Limassol, Cyprus, before and following its energy retrofit. The retrofit involved implementing a double skin façade and integrating active solar electricity systems within the building.
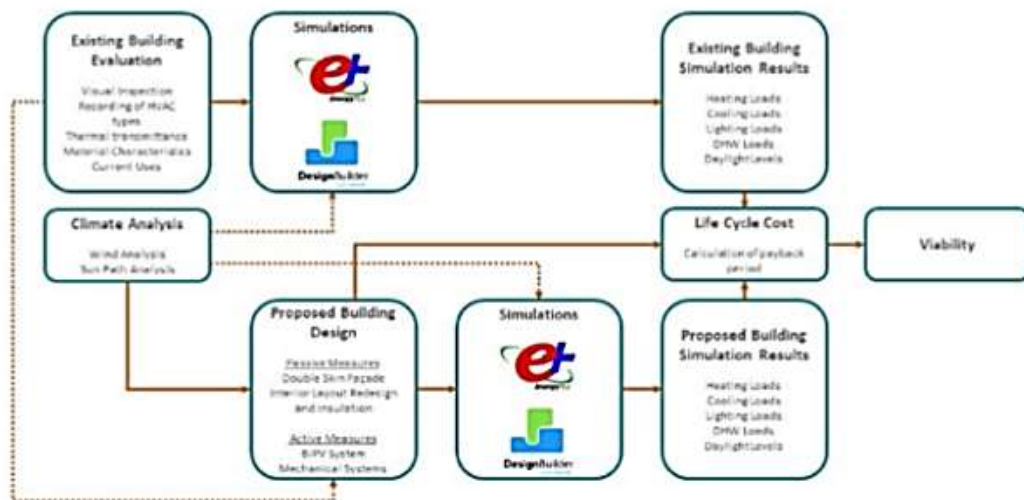


**Figure 6**. The methodology followed by (Italos et al., 2022)

The research process employed by Italos et al. (2022) for the comprehensive energy renovation of the building encompassed a multi-stage and innovative methodology to identify the potential for integrating new systems within the pre-existing structure. The methods employed to develop the research are depicted in Figure 6. The investigation commenced by assessing the building's existing systems and envelope to determine areas for improvement and potential pathologies. The scope of the study encompasses several aspects, including examining the current building envelope (evaluating its condition, thermal transmittance, and material properties) and assessing the Heating, Ventilation, and Air Conditioning (HVAC) system. The results from their study include:

a) Incorporating sustainable strategies and integrating active solar energy systems into the design process can substantially decrease energy demand and enhance the energy efficiency of new and existing buildings.

b) The utilization of a double façade, which incorporates a building-integrated photovoltaic system (BIPV), glazing system, and extensive vegetation, enables the synergistic integration of the advantageous features of each component. This integration results in a substantial decrease of 83.5% in the energy consumption of the building.

c) The viability of the enterprise assessed through a life cycle cost (LCC) analysis revealed that a reasonable integration of bioclimatic design and active solar systems could result in a feasible payback period.

Yoon et al. (2023) utilized both experimental inquiries and simulation analyses to propose a retrofitting strategy that entailed the installation of an expanded double-skin exterior (DSF) system. The system fulfils a dual role by replacing the current exterior windows and serving as a heat buffer for old-age dwellings in South Korea. The energy efficiency analysis was carried out using the EnergyPlus simulation software, and the simulation models were calibrated by incorporating empirical data gathered between October 1, 2019, and January 15, 2020. The authors employed the collected empirical data to calibrate the simulation model. Therefore, the study incorporates various methodologies, including experimental examination, analysis of simulations, and calibration of the simulation model using real-world experimental data.

Calibration results were derived from the simulation model using the hourly measurement data obtained from the study. The time intervals during which electricity consumption data were recorded spanned from November 4, 2019, to November 11, 2019, and from December 1, 2019, to January 15, 2020. These periods encompassed the actual measurement data gathered between October 1, 2019, and January 15, 2020, by the authors. The results of their research showed that:

a) The DSF system exhibits promising capabilities in achieving a substantial decrease in energy consumption, reaching up to 44.1%. This outcome is made possible by effectively harnessing the electricity generated by photovoltaic (PV) panels integrated within the DSF system.

b) The period of payback, as calculated based on the energy price offered by the energy supplier, was estimated to be around 15 years. Even with the prolonged duration for repayment, the technology demonstrated substantial promise in energy preservation and alleviating $CO_2$ emissions.

## Vertical Greenery System

Zhang et al. (2019) conducted a study utilizing field measurements to investigate the thermal properties of vertical green walls (VGFs) and their impact on the temperature in indoor and outdoor environments within a subtropical urban region during hot weather. The thermal balance of the vegetation canopy was determined by analyzing the foliage's net transpiration and photosynthesis rates. This analysis enabled the estimation of the thermal effects caused by plant physiological processes. The authors conducted measurements of the operative temperature (OT) and wet bulb globe temperature (WBGT) to assess the overall influence of the vegetative green façade (VGF) on the thermal conditions both indoors and outdoors.

Table 5 provides a comprehensive overview of the instruments and sensors the authors utilize in their field measurements. Acknowledging that every sensor underwent calibration procedures before its utilization is imperative. The pyranometers, pyrometers, thermocouples, and heat-flow sensors were connected to a data acquisition system that systematically sampled all sensors at regular one-minute intervals and stored the gathered data on a nearby server.

Figure 7 depicts the variations in the external surface temperature (two) and internal surface temperature (twi) of the western walls in both experimental chambers, alongside the corresponding air temperature (ta) within the partitions. The measurement results of the two test rooms displayed similarity, as evidenced by mean variations of 0.7 °C for the outside temperature, 0.7 °C for the inner surface temperature, and 0.3 °C for the ambient temperature. The deviations mentioned above were considered acceptable for the authors' on-site measurements. Upon the conclusion of the study, the following subsequent findings were obtained:

a) Solar radiation is the primary contributor to the thermal influx in the vertical vegetation canopy, exerting a dominant influence on its energy equilibrium. Within the vegetation canopy of the VGF (Vertical Greening System), the transpiration process facilitates the consumption of over fifty per cent of the solar energy absorbed, thereby establishing transpiration as a pivotal mechanism for cooling purposes.

b) Approximately 30% and 20% of the direct sunlight absorbed undergoes dissipation through longwave radiation exchange between the canopy and the surroundings and convective heat transfer between the foliage and the air.

c) The thermal effect ratio, which compares net photosynthesis to transpiration, is less than 5.5%. This implies that neglecting the thermal impact of net photosynthesis in the thermal balance computation for the climbing plant could result in an error of, at most, 2.9%. The occurrence of such an error may be deemed acceptable within the framework of diverse engineering applications.

| Measurement content | Sensor type | Accuracy |
|---|---|---|
| Vertical global radiation | CMP3 pyranometer | ± 5.0% |
| Vertical infrared radiation | IRO2 pyranometer | ± 5.0% |
| Surface/air temperature | 0.2 mm T-type thermocouple | ± 0.1 $^0$C |
| Globe temperature | HD 32.2 | ± 0.1 $^0$C |
| Wind velocity | | ± 0.5 m/s (0-1 m/s); ±0.15 m/s (1-5 m/s) |
| Air temperature | Hobo Pro V2 | ± 0.21$^0$C |
| Air relative humidity | | ± 2.5% (10-90% RH) |
| Heat flux | Heat-flow sensor | ± 3% |
| Electricity consumption of the air conditioner | Automatic electricity meter | ± 0.9% |

**Table 5.** Measurement tools and parameters (Zhang et al., 2019).
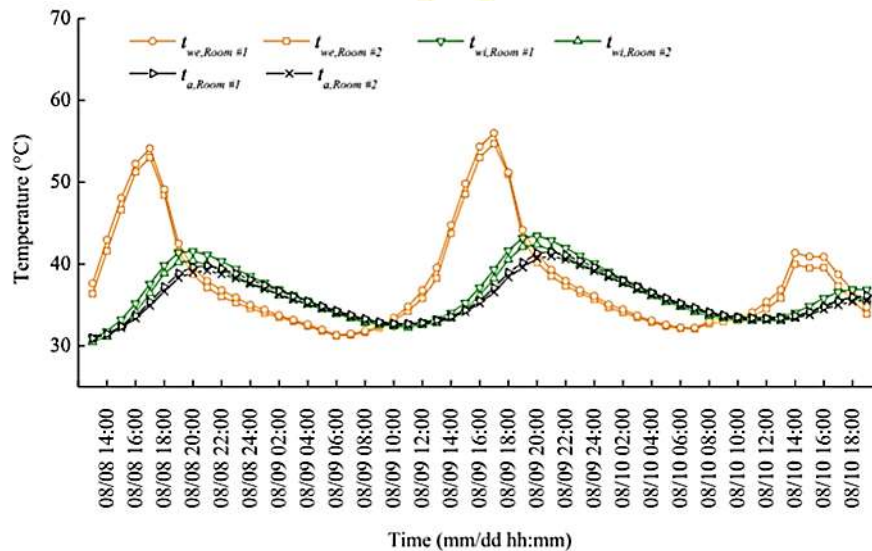


**Figure 7**. Validation measurement results before integration of Vertical Greenery Façade (Zhang et al., 2019)

In their recent study, Jovanović et al. (2022) analyzed the utilization of natural materials for insulation purposes in building facades, as well as the impact of ventilated green faces on the energy efficiency of buildings. Jovanović et al. (2022) provided a comprehensive overview of ventilated green facades' fundamental classifications and components. The research employed a literature review and analyzed case studies to examine guidelines and best practices for green-ventilated masks.

Evaluating a building system's energy efficiency can encompass the analysis of energy savings and consumption throughout all stages of the facility's construction and operation. The phases encompass the manufacturing of fundamental and supplementary construction materials, the establishment of standardized features of the constructed entity, the transportation of materials to the construction site, the arrangement of material installation, the enduring energy expenses for heating, air conditioning, and ventilation, as well as the energy consumption during the refurbishment of the facility or the recycling of materials from the chosen construction system. The following are the conclusions from (Jovanović et al., 2022):

a)  The implementation of a ventilated facade system has the potential to enhance the energy efficiency of a building. This is primarily due to its ability to decrease the utilization of energy resources for heating and ventilation purposes while concurrently optimizing thermal losses.

b)  Using natural materials for insulation in the building's facade can enhance its energy efficiency.

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c) Dependence exclusively on mechanical heating, cooling, and ventilation systems can incur significant expenses and result in insufficiently ventilated indoor environments and fixed temperature conditions, potentially compromising human health.

Mohammad Shuhaimi et al. (2022) employed quantitative research methods to gather data and ascertain the overall thermal transfer value (OTTV) across multiple hypothetical case studies. Their research aimed to determine the comprehensive thermal performances and overall Outdoor Thermal Transmittance Values (OTTV) of various Vegetated Green Roofs (VGS) varieties.

The calculation of the Linear Green Wall yielded the most favourable thermal performance effect in terms of VGS, resulting in a more significant reduction in OTTV in Malaysia's tropical climate and geographical location. Moreover, the orientation of the VGS also plays a vital role in determining its effectiveness in reducing the Overall Thermal Transfer Value (OTTV), as different orientation factors can impact the value of the shading coefficient. The study's findings and conclusions indicated that:

a) VGS has a significant influence on the thermal performance of interior buildings. Specifically, it reduces the overall demand for cooling, which is the primary contributor to energy consumption in tropical climates.

b) The Linear Green Wall system is considered the most effective method of reducing heat transfer in the tropical climate of Malaysia.

c) VGS offers many benefits for individuals, economic growth, and the environment.

The study by J. Li et al. (2021) focused on improving indoor thermal comfort by implementing different vertical greening patterns. To assess the indoor thermal conditions, the authors utilized the Envi-met model and analyzed meteorological data for an entire year. The authors used the PET isotherm to elucidate the spatial distribution of thermal perception over the year. The research collected meteorological data at regular intervals of one hour, including measurements of air temperature, humidity level, wind speed, and wind direction. The data was obtained from the national meteorological monitoring station in Chenzhou, encompassing January to December 2018. The dataset was subjected to a transformation process, generating 288 unique monthly average values. The values were subsequently categorized into 12 groups according to their corresponding months. The study identified that:

a) Modular green walls exhibit the most significant percentage of livable PET, with linear green walls, facades green walls, and reference walls following in descending order.

b) The modular green wall pattern exhibits the most significant environmental advantages, boasting a significantly high percentage (73.42%) of livable PETs. These PETs encompass a range of conditions, including those deemed "comfortable," "slightly cold," and "slightly hot."

In research conducted by Zheng et al. (2020), an experimental investigation was carried out to assess the effectiveness of vertical greenery systems as window shading mechanisms for energy conservation during the summer season. The study utilized simplified movable models of green window shading methods and examined the shading performance using three different plant species.

The authors affixed 12 heat flux sensors in a configuration of 4 rows and three columns on the surface of the inner

window glass. The purpose of the arrangement was to quantify the heat flux transmitted across the glass surface. The measurement of the coverage rate by percentage (Cr) was conducted during the growth of plants utilizing binary images. At the end of the experiments, the authors concluded that:

a) The incorporation of green shading mitigated the effects of solar radiation and the disparity in indoor-outdoor air temperature on the consumption of cooling energy.

b) The green shading decreased the correlation coefficient ($C_c$) between cooling energy consumption and ambient solar radiation from 0.94 to 0.61. Similarly, the $C_c$ between cooling energy consumption and indoor outdoor air temperature difference decreased from 0.92 to 0.79.

c) The shading performance of a west-facing window was observed to be most effective when exposed to oblique solar incidence angles.

## Passive Climate Control Principles

In a thorough examination of the efficacy of passive cooling techniques for radiation control in buildings, Chan et al. (2022) conducted a comprehensive study of three passive energy-efficient methods: thermochromic bright windows, daytime radiative coolers, and reflective paints through a field experiment.

The cooling effect of materials was investigated using three distinct methodologies: laboratory experimentation conducted indoors, field experimentation conducted outdoors, and energy simulation conducted under varying conditions. The experiments by the authors involved measuring the temperature differential between developed and conventional materials when exposed to solar lamps or natural sunlight.



**Figure 8.** The study used the parametric variation process for a mid-rise commercial building (Trepci et al., 2021)

The authors arrived at the following after their investigation:

a) Passive cooling technologies, including thermochromic bright windows, daytime radiative coolers, and reflective paints, demonstrated their efficacy in effectively regulating heat transfer within buildings, thereby reducing electricity consumption associated with air-conditioning systems.

b) Geographical climates significantly influence the effectiveness of passive cooling technologies and are particularly recommended for implementation in hot/mixed environments where the need for cooling is predominant.

The authors utilized 18 contextual variations, encompassing factors such as height, distance, and plot orientation, as illustrated in Figure 8. These variations were applied to the six fundamental case models. A total of 108 instances were tested as a result of this. The authors have arrived at the following conclusions:

a) The incorporation of a parametric adjustment in the height, distance, and orientation of the urban environment demonstrated a significant reduction in the need for cooling. The above decrease resulted in a maximum reduction of 26% for total cooling demands and 24% for top cooling demands.

b) The most significant energy usage reductions were observed in residential and commercial construction simulations when the urban environment demonstrated proximity and increased height, improving shading effects between buildings.

c) The achievement of energy savings through the reduction of context distance was observed to be effective solely in cases where the context height had already reached a level classified as either "medium" or "high". The concept of context height can be regarded as an essential and fundamental passive cooling strategy that efficiently utilizes interbuilding shading effects.

L. Li et al. (2021) conducted a study to examine the utilisation of solar heating technology in recently constructed buildings in the Western Sichuan Plateau. Based on the abovementioned findings, a proposed transformation scheme has been introduced to build cost-effective passive solar heating structures that necessitate minimal maintenance in the specified region. To accomplish their objective, L. Li et al., (2021) conducted direct measurements of the indoor thermal conditions in recently constructed buildings located in Seda County. These measurements aimed to evaluate the degree of comfort the indoor thermal environment offers. The study's authors arranged the test points within the indoor environment in a specific manner. The elements above encompassed the south-facing room situated on the initial floor, the living room located on the first floor, the main bedroom positioned on the second floor, the south-facing room located on the second floor, and the north-facing room set on the second floor.

Furthermore, the DeST-h software was utilized to simulate and analyze the recently constructed buildings and those employing passive solar heating. The outdoor air temperature ranged from -22.9 to 6.7 degrees Celsius, with the minimum recorded value occurring at 8:00 on January 24th. The maximum value was recorded at 15:00 hours on January 30th. Based on the data collected regarding indoor temperature, it is apparent

that three rooms experience a deficiency in heating during the winter season. The rooms above encompass the south room on the first floor and the room on the first floor within the northern section of the building. The indoor temperature displays fluctuations within the intervals of -0.4 to 2.7 degrees Celsius, 0.3 to 6.7 degrees Celsius, and -2.8 to 2.6 degrees Celsius.

The observed maximum temperature difference was 5.4 degrees Celsius. The provision of heating in the living room and main bedroom on the first floor was facilitated by a rudimentary earth stove. Figure 9 illustrates indoor temperature fluctuations, ranging from 6.3 to 12.2 ∘C and 4.6 to 13.5 ∘C. The maximum change observed is 7.9 ∘C.

Trepci et al. (2021) conducted a comprehensive assessment of the constructed urban environment's influence on buildings' energy efficiency in the face

of extremely high temperatures. The authors employed building energy modelling, an extensive parametric variation approach, and a statistical analysis scheme to accomplish this objective. This integrated methodology was utilised to effectively quantify the impact of inter-building shading on energy performance.

The authors reached the following conclusions from their study:

a) The solar building under consideration exhibits enhanced efficiency in collecting solar heat and notably enhances indoor thermal comfort without the need for supplementary heat sources.

b) The average monthly solar energy collection value during heating is 1050.83 W. The guaranteed rate of solar heating is approximately 31% and 26% when the essential room temperature is 16 • C and 18 • C, respectively.

The findings presented in their study, as shown in Figure 11 for all climates, demonstrated the influence of the passive components of the building, specifically thermal insulation, on achieving energy self-sufficiency. The observed values indicated a substantial impact in this regard. The experimental values suggest that the energy self-sufficiency of the analyzed building has the potential to be enhanced across all the examined climates. The potential for improvement in Agadir, Tangier, Fez, Ifrane, Marrakech, and Errachidia has been observed at percentages of 13.14%, 16.15%, 29%, 41.28%, 24.77%, and 36.02%, respectively by the authors.

Chegari et al., (2020) examined the influence of thermal insulation, as a component of the passive design of a typical Moroccan Rþ1 building, on its energy self-sufficiency across various climatic conditions. The researchers utilized the TRNSYS simulation studio to create a comprehensive and targeted platform for calculating this impact to achieve this objective. The study focused on a case study of a representative Moroccan building. The platform integrates a complete hybrid system that utilizes two innovative and environmentally friendly sources of renewable energy (wind turbine and photovoltaic energy) to meet the thermal demands of the building. Figure 10 shows the energy performance evaluation chart used for the system.
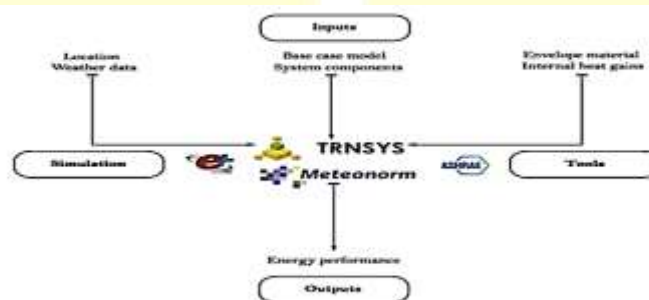


**Figure 10.** Energy performance evaluation chart of the studied system (Chegari et al., 2020).
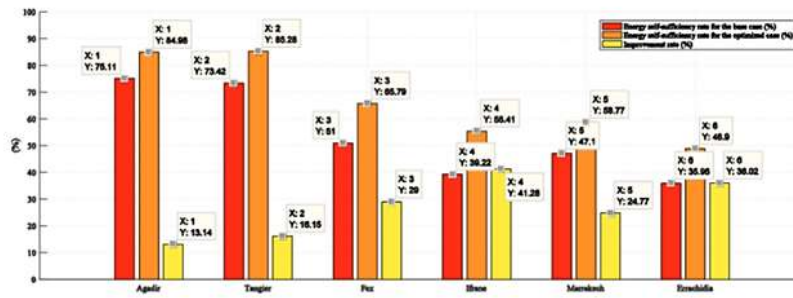
**Figure 11.** The disparity in energy self-sufficiency rates between the base case and the optimized case within the selected urban areas (Chegari et al., 2020).

The authors proposed the inclusion of numerical indicators in the Moroccan building thermal code to assess the influence of the passive components of a building on its energy self-sufficiency to promote public engagement in sustainable building practices. The authors arrive at the following conclusions:

a) Thermal insulation substantially affects the energy self-sufficiency of buildings across all examined climates, with particular significance observed in Ifrane City, Morocco.

b) The level of energy self-sufficiency in the climate experienced a significant improvement of 41.28% compared to the baseline scenario.

c) The attainment of thermal comfort was accomplished by mitigating energy losses, resulting in a notable potential for substantial savings.

In their study, Mushtaha et al., (2021) utilised a simulation-based approach to evaluate the impact of passive design methods on the cooling demands of buildings in a temperate climatic region. The authors employed the Integrated Environmental Solution-Virtual Environment (IESve) software to assess the efficacy of buildings, with a particular emphasis on solar shading performance. Furthermore, the study by Mushtaha et al., (2021) employed the Climate Consultant Software to examine different aspects of the local climate and identify the passive techniques required to achieve optimal thermal comfort in residential buildings. The authors utilised the IESVE simulation software to evaluate specific parameters' impact on energy consumption.

| Case/Average Temperature ($^0$C) | Avg. Outdoor | Basement | Ground Floor | First Floor | Penthouse | Stairwell | Av. indoor Spaces |
|---|---|---|---|---|---|---|---|
| Case 1: Reference/Baseline | 30 | 31.95 | 34.56 | 35.30 | 34.74 | 33.52 | 34.01 |
| Difference (av. in-out) | | 1.95 | 4.56 | 5.30 | 4.74 | 3.52 | 4.01 |
| Case 2: Natural Vent. | 30 | 27.05 | 31.53 | 33.04 | 32.84 | 31.32 | 31.12 |
| Baseline case diff (2-1) | | -4.89 | -3.03 | -2.26 | -1.90 | -2.20 | -2.86 |
| Case 3: Shading Devices | 30 | 30.83 | 33.28 | 33.57 | 32.91 | 32.52 | 32.62 |
| Baseline case diff (3-1) | | -1.12 | -1.28 | -1.73 | -1.83 | -1.00 | -1.39 |
| Case 4: Shad+vent+WWR=30% | 30 | 26.77 | 30.94 | 32.28 | 32.39 | 30.75 | 30.62 |
| Baseline case diff (4-1) | | -5.18 | -3.63 | -3.02 | -2.35 | -2.77 | -3.39 |
| Case 5: Shad+vent+ins.+WWR=15% | 30 | 24.5 | 25.54 | 25.12 | 27.43 | 28.06 | 226.13 |
| Baseline case diff (5-1) | | -7.45 | -9.02 | -10.18 | -7.31 | -5.46 | -7.88 |

**Table 6.** Indoor and outdoor summer air temperature for case study floors (Mushtaha et al., 2021).

A notable enhancement was noted in the ground and first floors, exhibiting temperature differences of -9.02 ∘C and -10.18 ∘C, respectively. Moreover, the

situation presented the highest degree of proximity to achieving a state of comfort within the residential areas. There was a significant decrease in temperature of approximately -7.88 ◦C in the living spaces, resulting in an average air temperature of 26.13 ◦C. Similarly, the penthouse experienced a temperature decrease of -7.31 ◦C, reaching an average air temperature of 27.43 ◦C (refer to Table 6). At the end of the evaluation study by Mushtaha et al., (2021), their findings and conclusions include:

a) After analyzing various cases, it was found that the integration of ventilation, shading elements, and insulation exhibited the highest level of effectiveness, leading to a substantial decrease in energy usage by 59%. The building design in Case 5 implemented a range of strategies to improve its thermal performance and optimize energy efficiency. The methods employed included utilizing shading components, thermal insulation, outdoor ventilation, and small openings with a window-to-wall ratio (WWR) of 15%.

b) Implementing effective passive designs, such as using high heat resistance materials in the walls, led to a significant annual reduction of 23.2%.

This finding suggests that the integration of such materials can enhance thermal comfort.

## CONCLUSION AND FURTHER WORKS

Upon obtaining raw data of the indoor temperature of a selected curtain wall high-rise office, which was above international comfort standards, the authors carried out a comprehensive review of five selected articles, each under Shading Devices (SD), Phase Change Materials (PCM), Vertical Greenery Systems (VGS), Passive Climate Control Principle (PCCP) and Double Skin Glass Facades (DSGFs) in other to suggest a solution to mitigate the present discomfort level in the curtain wall office as a result of high temperatures. The authors found that the current office temperature of the studied building is above international comfort standards and requires optimization. The study concludes that;

a) The review agreed with existing literature on the capacity of the outlined thermal performance solutions based on their advantages to optimize indoor thermal performance.

b) Among the solutions reviewed, shading devices have more advantages in Abuja climatic conditions.

c) Shading devices in the form of fins, cantilevers and overhangs do not require electrical energy, making it a sustainable solution.

d) Shading devices are more economical than the other solutions in the review.

e) Shading devices mitigate the sun radiation while allowing adequate illumination of the office interior spaces.

f) Shading devices reduce interior spaces' cooling needs in hot climates.

Given its advantages, the authors believe that incorporating shading devices into the design of Abuja curtain wall offices will optimize the thermal performance of the indoor office environment, thereby making the office comfortable for human occupation. The study conducted a rigorous evaluation of the raw data obtained from the data loggers without considering other glass factors that may influence thermal performance. It is proposed that additional research be conducted to investigate the impact of various factors on curtain walls in office buildings in Abuja. The effects of different types of glass, colors of glass, the

thickness of glass, and the presence of openable windows should be explored.

## ACKNOWLEDGEMENT

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# UNLOCKING INNOVATIVE DEVELOPMENTAL OUTCOMES IN THE BUILT ENVIRONMENT USING MEANS-END CHAIN MODEL: A BIBLIOMETRIC AND SCIENTOMETRIC REVIEW

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## ABSTRACT

The Means-End Chain (MEC) research model has progressively been adopted to explore socio-cultural values, preferences, and choices in the built environment since the early 2000s. Since sustainability entails innovating economic and environmental solutions based on peoples' social concerns, MEC analysis results can fill the context-based development gap. This study analyzed 537 MEC-related materials from the Scopus database to identify the main themes, authors, affiliations, and journal sources for effective following by new researchers in the area concerned. The bibliometric analyses revealed the main themes in MEC research for eliciting product perception, consumer values, utility preferences, and other socio-cultural concerns in the built environment. Trends keywords in the built environment included heritage tourism, rural development, hedonic analysis, cultural influence, student stakeholder, sustainability, covid-19, office buildings, and resident perception. The presence of only one author making the top ten list shows limited sources in the built environment disciplines utilizing the MEC research model. However, emerging journals in tourism, environment, and housing were identified as potential sources for new scholars in the area. The study also found trending keywords relating to the built environment, including housing choice, tourism, sustainability, rural development, residents' satisfaction, stakeholders' participation, and preferences in office buildings. Since using the MEC model in the built environment is still experimental, this study recommends combining emerging themes with other trending socio-economic concerns to achieve innovative developmental outcomes.

*Keywords: Bibliometrics, Emerging themes, Innovative potentials, Means-end chain, Scientometrics, VOSviewer*

## INTRODUCTION

Means-End-Chain (MEC) is a research model that describes how a product or service choice assists in attaining preferred final positions (Lin, Jeng, & Yeh, 2018; Zinas & Jusan, 2017). According to Moghimi, Jusan, and Izadpanahi (2016),

the MEC theory has become increasingly popular in the built environment with constantly evolving versatility as a research domain to satisfy humans' ever-changing physiological and psycho-social needs. Nevertheless, the most crucial impression of MEC in attaining personal values is that end-users usually select activities that yield favourable consequences, thereby minimizing actions with undesirable outcomes (Zinas & Jusan, 2017).

Historically, Gutman (1982) pioneered the MEC model, focusing on in-depth qualitative analysis or laddering for behavioural and end-state motives of end-users (Chen, Wang, & Chen, 2018; C.-S. Lin et al., 2018). The theory was further developed and propagated by Reynolds and Gutman (1988) through the practical description of MEC interviews' conduct, analysis and application, which has since become a valuable and dynamic domain of productive enquiry outcomes (Zinas & Jusan, 2017). A product, which could be a house, tourism site or even food, is usually filtered through its Attributes (A), linked to its utility Consequences (C), to satisfy the personal Values (V) of the individual or community (Moghimi et al., 2016; Moghimi, Jusan, Izadpanahi, & Mahdinejad, 2017). The ensuring A-C-V structure, therefore, formulates a ladder for MEC analysis in product-value exploration.

At present, the MEC is becoming widespread in practical disciplines in the built environment, such as architecture, landscaping, leisure and tourism, regional planning, and urban design, among others (Bapiri, Esfandiar, & Seyfi, 2021; C.-S. Lin et al., 2018; Richter & Bokelmann, 2018). The application of MEC in the built environment mostly elicits human perceptions concerning choice and preferences in attaining service delivery and product satisfaction (Aule, Majid, & Jusan, 2022b, 2022a; Aule, Majid, Jusan, & Ayoosu, 2022; Zinas & Jusan, 2017). It is imperative to note that the adaptation and application of the MEC model for research in the built environment is still emerging, with a dearth of literature sources. According to Zinas (2013), the

first attempt to adapt the MEC research method in measuring design appropriateness in the built environment commenced with the works of Coolen and Hoekstra (2001) on housing preference in the Netherlands. Jusan (2007) then utilized the model to measure housing personalization potentials in Malaysia. Similarly, Zinas and Jusan (2012a, 2012b) applied the framework to evaluate interior preference and choice of housing in Nigeria.

Today, the theory has innovative prospects of eliciting socio-cultural values in the built environment in establishing choices and preferences for participatory development and space personalization at the level of individual, family or community (Aule, Jusan, Majid, & Ayoosu, 2021; Aule, Majid, & Jusan, 2022b, 2022a; Aule, Majid, Jusan, et al., 2022; Moghimi & Jusan, 2015; Moghimi et al., 2016, 2017; Wong & Jusan, 2017; Zinas & Jusan, 2017).

This study explores the growing application of the MEC research model to measure preferences and choices in housing and architecture, as well as other promising disciplines in the built environment, such as planning, landscaping, leisure and tourism, facility management, waste management, among other perceptive measurements on science and engineering. For productive research in the built environment with the MEC model, young scholars may wish to identify the main themes that emerged over time, emerging issues that may hitch-hike research interests, follow proficient authors in the area, and the top journal sources to publish their results. In this scoping review, bibliometric information on MEC publications was mined from the Scopus database, screened, and utilized for scientometric analysis in the form of co-authorship, co-citations, and co-occurrence, using the VOSviewer software to simulate systematic mappings and connections of themes, authors, journals, and emerging keywords. Relevant information was generated across disciplines to guide young scholars in making informed decisions on variables for project titles in the built environment.

# MATERIALS AND METHODS

The methods in this study involve a description of decisions made in selecting document sources for inclusion in the study, data screening, justifying excluded materials, selecting data analysis tools, and choices for data presentation, as shown in Figure 1.
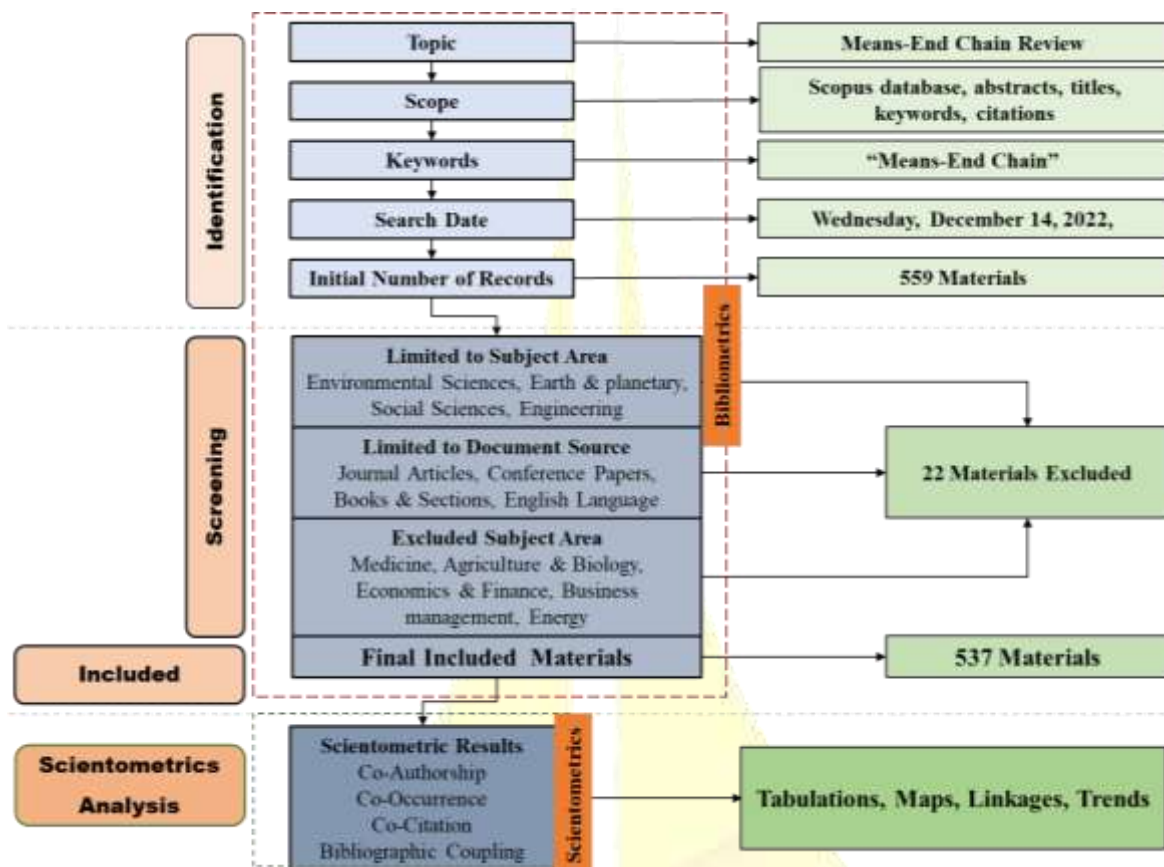


**Figure 1:** Systematic Data Identification, Screening, and Inclusion

**Database:** This study utilized the Scopus database as the primary material source due to its broader coverage of relevant and quality publications. Since its inception in 2004, the Scopus database has increasingly become a top choice for publications due to its comprehensive nature, including research from a wide variety of subjects (Abbas, Jusoh, Mas'od, Alsharif, & Ali, 2022; Ghaleb, Alhajlah, Abdullah, Kassem, & Al-Sharaf, 2022; Oguntona, Aigbavboa, & Dywili, 2022; Sahi et al., 2022). Another choice of the Scopus database is its provision for mining 2,000 documents simultaneously for scientometric data analysis using VOSviewer software

**Data Identification:** The data identification, screening, and inclusion in this study utilized the Systematic Review approach based on the principles of PRISMA - Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Page et al., 2021). According to the study, the PRISMA principles include "identifying" articles through keywords, "screening" the sources to exclude extraneous materials and deciding on the materials to be "included" for further evaluation (p.5). This study was limited to the Scopus database in the materials identification to check the complications of analyzing data from varied sources using the VOSviewer software in its current edition.

The query string of "Means-end chain" was inputted to produce materials containing the keyword " Means-end" on the one hand and "chain" on the other. When the query string was inputted as the keywords for data mining, a total of 559 documents initially resulted, leading to the subsequent stage to screen and refine the materials and sources.

**Data Screening:** Data screening was necessary to streamline the materials and attain the standards for utilizing the VOSviewer package. The search query on Wednesday, December 14, 2022, was further screened to streamline the data. The sources were also restricted to English materials, excluding those printed in Chinese, Portuguese, Russian and Spanish. Without other restrictions to material sources, contexts and years, the final results of 537 materials were realized from the query search string:

*TITLE-ABS-KEY ("means-end chain") AND ( LIMIT-TO ( LANGUAGE, "English" ) ) AND ( EXCLUDE ( LANGUAGE," Chinese" ) OR EXCLUDE ( LANGUAGE," Portuguese" ) OR EXCLUDE ( LANGUAGE, "Russian" ) OR EXCLUDE ( LANGUAGE," Spanish" ) ).*

The Scopus database can support up to 2,000 materials to be exported simultaneously to the VOSviewer software (van Eck & Waltman, 2022), and the final query results were deemed sufficient to conduct the scientometric inquiries.

**Data Inclusion:** With the satisfactory results of materials inclusion, the 537 materials were exported as CSV (comma-separated values) files into Microsoft Excel, along with their bibliographical and reference contents. Other important bibliometric information includes author names and affiliations, journal type, and rankings, most of which are available in the Scopus database. The included materials were finally exported and downloaded as a single Microsoft Excel file to the computer system and loaded in the VOSviewer software for the scientometric analysis.

**Data Analysis Tool:** The VOSviewer computer program version 1.6.18.0 was utilized for the bibliometric and scientometric evaluations. VOSviewer is a free computer software for scientometric data analysis. Scientometrics involves an objective and reliable review of the analysis of material sources, converting qualitative information into quantitative data by creating graphical relationships (Oladinrin, Gomis, Jayantha, Obi, & Rana, 2021). According to the software producers (van Eck & Waltman, 2022), the VOSviewer is a software application for building maps based on network data and displaying and investigating these maps. It creates maps based on network data and visualizes and explores them to create meaningful relationships. The computer software creates distance-based network maps where the distance among nodes indicates closeness and connections (Oraee, Hosseini, Papadonikolaki, Palliyaguru, & Arashpour, 2017).

Data previously exported from the Scopus database were inputted into the VOSviewer software, units of analysis selected, and results generated as map-based co-authorship, co-occurrence, and co-citation, among others. The results established relevant information concerning critical linkages to authors, journals, and research topics, highlighting novel areas for further productive research.

## RESULT AND DISCUSSION

The findings from this scientometric review were analyzed based on the bibliometric information obtained in the Scopus database and the network maps generated from the VOSviewer program. Subsequently, the results were examined regarding the document type, main themes, authors, source titles, and contextual affiliations before highlighting the emerging trends in applying the MEC theory for research.

**Documents in MEC Research:** No limitation was not placed on the Source Type, thereby mining materials from journal articles, books, reviews, and conferences, among others. The 537 included materials were mined and exported as Microsoft Excel files to the personal computer. By the search preferences, more than 77% of mined materials were journal publications, and 14% were conferences, making the remaining nine percent produced as

books, reviews, and notes, among traces of sources. As presented in Figure 2, the Subject Area produced about 26% of materials in Business Management, 13% in Social Sciences, 12% in Computer Sciences, 11% in Agriculture, and the remaining traces in economics, engineering, psychology, and environmental sciences, among other disciplines. The bibliometric document analyses were done using the bibliographic information mined in the Scopus database. Most publications on the MEC theory in social sciences confirm its importance in humanities and social sciences (Aule, Majid, Jusan, et al., 2022; Azouz & Sameh, 2020).
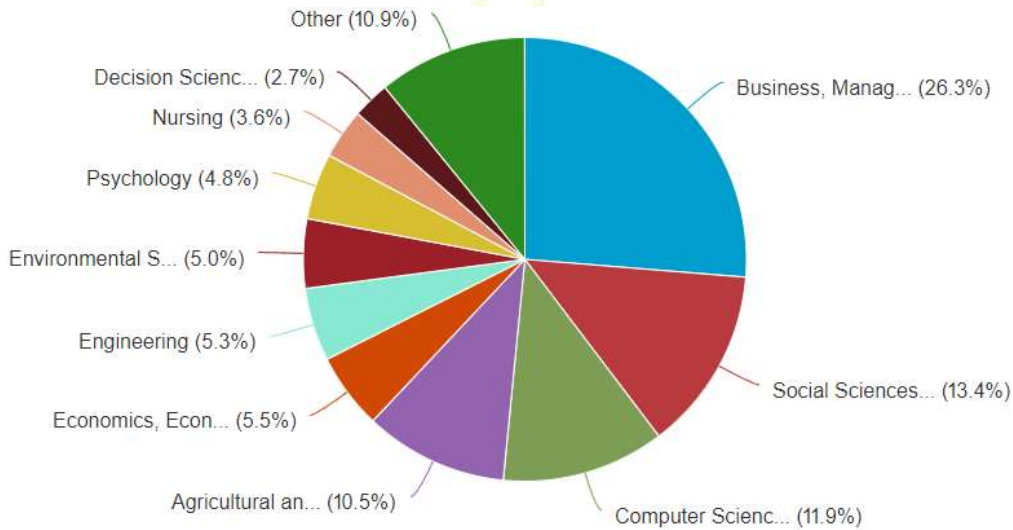


**Figure 2:** Distribution of MEC Documents Based on Subject Area

Without restriction in the Year of Publication, the results show that applying the MEC theory for research commenced in the early 1980s. According to Zinas and Jusan (2017), the MEC has been an ever-evolving research model since its introduction by Gutman (1982), inspired by the laddering studies by Yankelovich (1981), based on the classification of values by Rokeach (1968). MEC theory reached a milestone of more than ten publications at the turn of the new century, reaching its peak in 2022 with 42 publications, as presented in Figure 3.
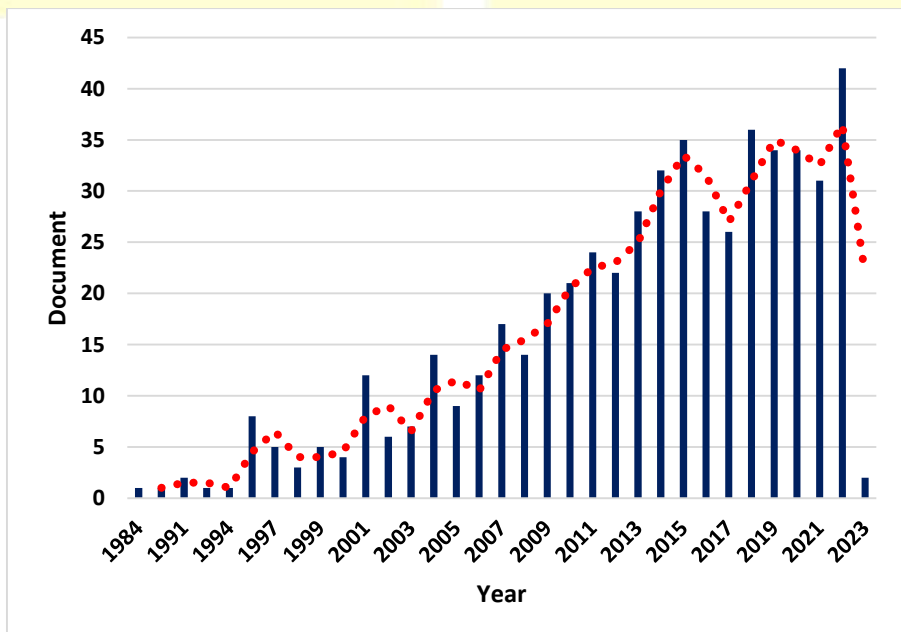


**Figure 3:** The Rising Profile of Research Using MEC Theory

**Central Themes in MEC Research:** The search results in the Scopus database identified four main clusters representing the main themes in the MEC research application. The four themes that emerged in MEC studies, as presented in Figure 4, include Product Perception (red), Consumer Values (green), Utility Preferences (yellow), and Socio-cultural Contexts (blue).
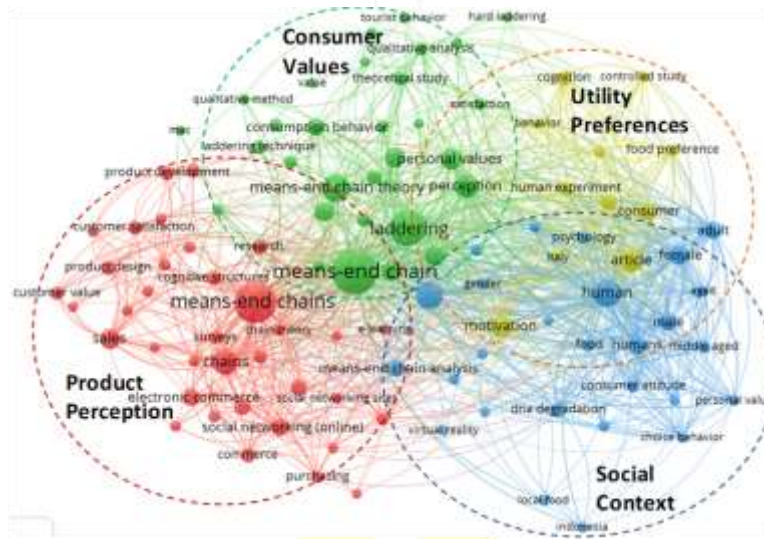


**Figure 4:** Network Visualizations Showing Main Themes in MEC Research

Comparatively, the themes align with findings by scholars that human values, preferences, and perceptions are the principal concerns for MEC research (Lin et al., 2018; Wang, Xie, Ali, Brem, & Wang, 2022; Wong & Jusan, 2017). In a limited manner, the themes also depict the current issue of Sustainable Development Goals (SDGs) with its social, economic, and environmental pillars.

Prominent items in the Product Perception cluster (red) include product development, customer satisfaction, social networking, and cognitive structures, among others; Consumer Values (green), on the other hand, involve laddering techniques, personal values, and tourist behaviour. The prominent elements in the Utility Preferences (yellow) are food preferences, human experiments, cognitive behaviour, and controlled study. Sphere of Socio-cultural Contexts (blue) includes human behaviour, local food, virtual reality, and consumer attitude, with authors spread over the globe. New scholars entering the MEC methodological area should note the themes carefully to make informed decisions on their contextual applications. The Scientometrics mapping of the themes involves a systematic blend of the occurrences and total links of the keywords in the 537 documents and sources under examination.

**Prominent Authors in MEC Research**
This section presents the top ten prolific and most cited authors utilizing the MEC theory for methodological investigations. Knowledge of the top authors in the study area will spur research, encourage collaboration and enhance effective networking for interdisciplinary productivity (Khudzari, Kurian, Tartakovsky, & Raghavan, 2018; Yu, Wang, Zhang, & Zhang, 2018). New scholars in the subject area will also have direction concerning the authors to follow, their articles, and their impact. Besides the authors' names, their respective number of articles, citation metrics, and disciplines were also captured alongside their most cited publications and scientometric links, respectively, as shown in Table 1. Though the authors were ranked according to the number of documents resulting in the query string, their h-index impact, representing the citation ratio per document, was also computed. From the search results, Lin, C. F. is the most prolific publisher using the MEC model with 24 materials.

**Table 1:** Bibliometric Analysis Showing Top-Ten Researchers Using MEC Model

| S/N | Author | Discipline | Docs in Query | Total Pubs | Total Citation | h-index | Sci-Link | Most Cited Article |
|---|---|---|---|---|---|---|---|---|
| 1 | Lin, C.F. | Business Administration | 24 | 32 | 277 | 9 (7) | 24 | (Lin, 2002) |
| 2 | Fu, C.S. | Business Administration | 15 | 33 | 497 | 12 (5) | 22 | (Wu, Lee, Fu, & Wang, 2013) |
| 3 | Barrena, R. | Business Administration | 11 | 23 | 553 | 11 (6) | 14 | (Barrena & Sánchez, 2012) |
| 4 | Sánchez, M. | Business Administration | 11 | 75 | 2,626 | 29 (2) | 13 | (MGil, Gracia, & Sánchez, 2000) |
| 5 | Arsil, P. | Agricultural Technology | 10 | 28 | 194 | 8 (8) | 37 | (Arsil, Li, Bruwer, & Lyons, 2014) |
| 6 | Grunert, K.G. | Communication | 9 | 291 | 15,044 | 62 (1) | 23 | (Grunert, n.d.) |
| 7 | Jusan, M.B.M. | Built Environment | 8 | 16 | 111 | 7 (9) | 11 | (Ghomeshi & Jusan, 2013) |
| 8 | Lin, Y.L. | Business Administration | 8 | 14 | 236 | 7 (10) | 10 | (Chu, Lin, Hsiung, & Liu, 2006) |
| 9 | Okello, J.J. | Agricultural Technology | 8 | 79 | 1,342 | 18 (3) | 31 | (Narrod et al., 2009) |
| 10 | Jung, Y. | Communication | 7 | 39 | 1,061 | 15 (4) | 7 | (Jung, Perez-mira, & Wiley-Patton, 2009) |

In that order, other authors with more than ten documents include Fu, C. S., Barrena, R., Sánchez, M., and Arsil, P. Outside the query area, the bibliometric information of the top-ten authors, as captured on the Scopus database, indicates that most of them published more than ten articles, with Grunert's 291 standing out. Most of the top authors in the area are in the field of Business Administration, two each in Communication and Agricultural Technology, and one in the Built Environment, respectively. The distribution also confirms the unique position of Marketing and business administration as an essential discipline in eliciting product values through its concrete attributes and consequential utility using the MEC theory (Fabbrizzi et al., 2017; Jiang, Scott, & Ding, 2015). Furthermore, the scientometric links were extracted in the VOSviewer analysis of the documents, sources, and citations. From the option to create a map based on bibliometric data, the document mined from the Scopus database was loaded, selecting the option "co-authorship of all authors". With a minimum of one document in the search, the total links generated from the co-authorship analysis show that Arsil and Okello have more than 30 link strengths across different contexts, three other top-ten authors having more than 20 links, with a majority having ten linkages and above. The patterns could also show that while authors in the same or similar disciplines have stronger link strengths, those outside their core disciplines have fewer links.

**Emerging Keywords in MEC Research:** Like the themes earlier identified above, the emerging Keywords and trends were also identified based on Product Perception, Consumer Values, Utility Preferences, and Socio-cultural Contexts. From the option to "create a map based on bibliometric data", the CSV document file extracted from the Scopus database was selected and loaded; co-occurrence of all keywords was further chosen from the resulting VOSviewer window.

The links of visible emerging keywords and trends with at least two mentions in the 2020s included heritage tourism (24), computer advice (19), collaborative consumption (14), sustainability (9), houses (8), veganism (7), destination image (6), employee benefits (5), product communication (5), and employee

attraction (4), as shown on the yellow scale in Figure 5.



**Figure 5:** Co-Occurrence Overlay Visualisations Showing Trends on MEC Research

Other hidden trending keywords with two keywords are the ethnic group (45), rural area (23), marginalization (17), hedonic analysis (16), cultural influence (16), digital storage (14), student (13), stakeholder (12), covid-19 (9), office buildings (9), resident (9), gamification (6), brand credibility (3), among others. Most of the emerging keywords and research trends are inclined toward business, humanities and social sciences, confirming the foundation of the MEC in marketing and merchandise research (Jiang et al., 2015; Zinas & Jusan, 2017). In addition, the simulation of keywords in the built environment, such as heritage tourism, housing, sustainability, rural development, residents, stakeholders, and office buildings, among others, confirms the increasing application of the MEC research model in the subject area (Abascal, 2019; Zinas & Jusan, 2017).

**Emerging Journal Sources in MEC Research:** As research using the MEC rapidly develops towards new and promising grounds, the results are also being published in various emerging journal sources across different contexts and disciplines. The Scientometrics mapping the emerging journal sources in this study involves a systematic blend of the bibliographic citations and total links of the journal sources under review. In the analysis of sources, "International Journal of Research in Marketing (451)", "Food Quality and Preference (364)", "British Food Journal (197)", "Psychology and Marketing (191)", and "Journal of Business Research (171)" remain the preferred journals for publication of research results with MEC model.

However, some emerging journal sources and linkages in publishing MEC research, with at least two materials as shown on the yellow timeline in Figure 6, are "Sustainability (Switzerland) (44)", "Journal of Internet Commerce (16)", "Sage Open (15)", Healthcare (Switzerland) (12)", "Journal of Services Marketing (10)", "Technology in Society (6)", "Journal of Heritage Tourism (4)", "Mathematical Problems in Engineering (2)", among others.

**Figure 6:** Bibliographic Coupling Showing Emerging Journal Sources Using MEC Model

Other emerging passive sources not visible in the mapping include "Telematics and Informatics (23)", "Marketing Intelligence and Planning (18)", International Journal of Environmental Research and Public Health (13)", "Current Issues in Tourism (12)", "Journal of Global fashion Mark (9)", "Tourism Recreation Research (9)", "Journal of Product and Brand Management (7)", among others.

The MEC, an emerging research model in new disciplines (Moghimi et al., 2016), particularly has limited journal sources in the built environment disciplines. Though, some emerging sources publishing articles with the MEC research model in the built environment include multi-disciplinary and trade journals such as "Sustainability (Switzerland)" "Sage Open", "Technology in Society", "Journal of Heritage Tourism", "International Journal of Environmental Research and Public Health", "Current Issues in Tourism", and "Tourism Recreation Research". Furthermore, since the built environment is a multi-disciplinary field comprising research in tourism, architecture, construction, landscaping and planning, as well as sociology, psychology, economics, anthropology, history, philosophy, and other academic and professional disciplines (Akinwande & Hui, 2022; Aule, Majid, & Jusan, 2022b; Philokyprou, Michael, Malaktou, & Savvides, 2017; Ruonavaara, 2018); built environment research may be published in multi-disciplinary media from different

backgrounds.

New scholars in the built environment exploring people's choices, preferences, and socio-cultural values, among other end-user participatory perceptions, should follow emerging journal sources and trending issues for productive research outcomes and timely publication of results.

## CONCLUSION

The MEC research model, initially developed to elicit end-user choices, preferences and values concerning product satisfaction, is finding innovative applications in the built environment. Using the MEC research model, this bibliometric and scientometric review mined and screened materials from the Scopus database to produce systematic connections concerning themes, trending keywords, prolific authors, and critical Journal sources.

Analysis of the 537 materials finally included established systematic themes in the MEC research over time. The analysis also produced the most prolific authors in the field, the continental contexts of its application, and emerging keywords, journal sources and countries. Most importantly, the emerging multi-disciplinary keywords were highlighted for innovative research direction recognizing trending issues, problems, and gaps by younger researchers wishing to explore choices, preferences, and socio-cultural values in the built environment. There is a need for young and seasoned scholars

exploring end-users perceptions of choice, preferences, and values in the built environment to know the emerging trends in MEC research, follow the publication of top authors in the field, and note the journal sources to publish their results. This versatile theory is, therefore, crucial in exploring intangible product perceptions, especially in the tangible disciplines of the built environment.

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# BUILDING SUSTAINABILITY AWARENESS AMONGST ARCHITECTURAL STUDENTS OF KADUNA STATE UNIVERSITY

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## ABSTRACT

Sustainability has become an increasingly important consideration in architecture, with the need for sustainable practices and designs becoming more pressing due to the negative impact of climate change. However, despite the importance of sustainability, many architectural students are not adequately prepared to fully incorporate sustainable practices into their building design projects. Thus, this research seeks to explore building sustainability awareness among Kaduna state university architectural students and their application of sustainability principles in their building design projects. Questionnaire survey was carried out to collect data from architectural students of the university. The level of awareness was measured through questions on what sustainable building is and what sustainable buildings can do. While the rate of application was developed around the principles of building sustainability which are: energy usage, water usage, occupants' health, material usage and environmental impact. 169 filled questionnaires were collected and analysed. Results revealed that the higher level students are familiar with the word "building sustainability" and in fact they are well aware of what a sustainable building is and what it can do. With regards to the students' application of sustainable principles, students majorly adopts natural ventilation and lighting in their building design as a means of energy saving while ignoring the reduction of cooling load through materials used and generation of renewable energy. For water and material usage majority of the students hardly considered these two in their design. Whereas, students are highly aware of the impact their building design has on occupants' health and the environment, as majority always and often considered occupants' health and environmental impacts in their design. Findings from this study will provide insights into the importance of early integration of sustainability into architectural education, to produce graduates who are well equipped to incorporate sustainable practices into their future designs.

*Keywords : Architectural students, Building sustainability, Sustainability awareness, Sustainability principles.*

## INTRODUCTION

The need for sustainable buildings has become increasingly urgent as the world faces climate change and other environmental challenges. Unfortunately, studies (Obia and Obot, 2016; Alsaati et. al., 2020) have revealed poor level of sustainability awareness amongst architects and architectural students in developing countries including Nigeria. Obia and Obot (2016) indicated that this could be a major reason why contemporary Nigerian architecture seems to lack the 'green' touch, this they considered a serious environmental and sustainability problem. Mohamed and Elias-Ozkan (2019) argued that there is indeed a clear lack of teaching pedagogy and instructive teaching tools for impacting the knowledge and implementation of sustainable architecture/building in university architecture students. Mohamed (2021) further emphasized on the fact that there is a need to embrace new principles to improve architectural undergraduate education, which can be used to help the integration of sustainability principles into the design studio. In agreement, Shari and Jaafar (2006) and Ozer, et. al. (2012) and added that building sustainability issues/practice/principles should be introduced to students earlier in order to produce educated, skilled and knowledgeable architects. It is thus necessary to reveal the level of awareness/knowledge of building sustainability amongst university architectural students and at the same time discover their rate of application of sustainable building principles in their design projects.

The role of education in promoting sustainability among architecture students cannot be over emphasized as architectural students are in a unique position to contribute to the development of sustainable buildings, as they are the future professionals in the industry. Thus a study by Saifuddin et al., (2019) found that incorporating sustainability into the architecture curriculum could significantly increase students' awareness and knowledge of sustainable design principles. The study recommended that sustainability should be integrated into all architecture courses to ensure that students develop a holistic understanding of sustainable design. Another study by Alshuwaikhat and Abubakar (2008) found that there is a significant gap between the knowledge and practice of sustainable design among architecture students. The study suggested that incorporating sustainable design principles into the curriculum and providing practical training opportunities could bridge this gap.

As one of the prominent institutions providing architectural education in Nigeria, Kaduna State University (KASU) has a responsibility to ensure that its students receive appropriate training that aligns with the evolving demands of the design profession. It is thus imperative of the university to prioritize delivering relevant and up-to-date education to its students in response to the changing needs of the architectural field. Therefore, it is crucial to ensure that the education and training of upcoming professionals in the field of architecture are appropriately guided, encompassing comprehensive processes that would inform sustainable practices in the architectural profession. In KASU "Introduction to sustainable architecture" as a course was introduced into the year 4 curriculum at the department of architecture, students are taken through what sustainable architecture entails, sustainable design principles and other relevant topics. Although this course is taken during the second semester of the final year, students' final design projects still failed to reflex their knowledge of building sustainability. It is important to note here that the course was introduced late into the curriculum and students are not expected to quickly integrate and apply what was just learnt in the final project topic/design that has been conceived a semester earlier.

With the growing rate of global interest on sustainability awareness in the building sector, students of architecture at all levels are expected to be equipped with this critical knowledge and awareness and as such put this knowledge in use in their building design projects. Thus, it is expected that an architectural student at the final level in the university display some level of knowledge and awareness on the issue of building sustainability. It is therefore important to study the level of awareness/knowledge of building sustainability amongst university architectural students and at the same time reveal their rate of application of sustainable building principles in their design projects.

Thus, this research aims to study the level of awareness/knowledge of building sustainability and the application of sustainable building principles amongst architecture students of Kaduna state university with the following objectives: 1. To determine the level of awareness/knowledge of building sustainability possessed by architecture students of Kaduna state university. 2. To revealed the students' application of sustainable building principles in their building design projects.

## METHODS

To fulfil the study's objectives and to answer the stated questions, a questionnaire survey was conducted to obtain information from students on their level of awareness on building sustainability and their application of sustainable principles in their design projects. Questionnaire survey is popularly used in awareness survey (Obia and Obot, 2016; Zaki et al., 2016; Malik et al., 2019; Alsaati et al., 2020; Michael et al., 2020) and it enables researchers cover an extensive amount of information on a variety of topics across a large number of people in a limited amount of time. Online questionnaire was adopted using Google forms.

Architectural students from year two to year four (200, 300 and 400 level) were involved while year one students were excluded. This is because at year one, an architectural student is not yet fully integrated into the department (they majorly offer courses from sciences and few core architectural courses). Students were briefed on the purpose of the survey; they were then taken through each question in the survey and how to appropriately answer them. All these were done before the link to the questionnaire was sent to each class whatsapp platform. The questionnaire is divided into three parts which are: Demographic characteristics, level of knowledge/awareness of sustainable building, and application of sustainable building principles.

The survey was carried out at the end of the 2021/2022 academic section when all level courses have been completed and all design projects have been done and submitted/presented. At this period students are waiting to move to the next academic level. At the end of the survey a total of 169 responses were realized from students of all three levels (200, 300 and 400 levels). The data from the survey questionnaire were analysed using SPSS software version 22 and excel spreadsheet. Relevant statistical analysis was carried out to fulfill the study's objectives. These analyses include necessary descriptive analysis such as frequency distributions and cross-tabulation.

## RESULTS AND DISCUSSION

### Demographic characteristics
The demographic characteristics of a group of 169 respondents, spanning all three levels of students, were examined by investigating their information. Figure 1 illustrates the distribution across the different student levels, while Table 2 presents the breakdown of their genders.
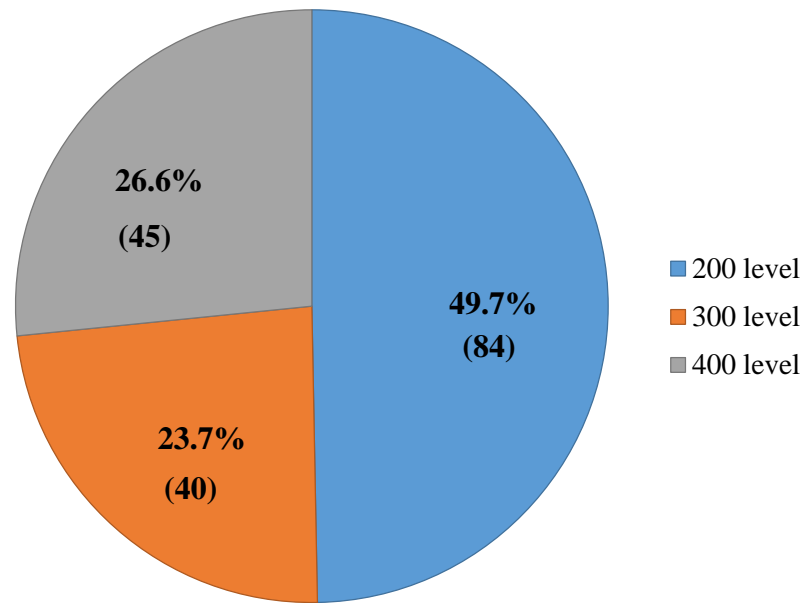
**Figure 1** Respondents' academic Level/Year (N = 169)

**Table 1** Students' gender

|  | Frequency | Percentage (%) |
|---|---|---|
| **Male** | 152 | 89.9 |
| **Female** | 17 | 10.1 |
| **Total** | 169 | 100 |

In Figure 1, the data reveals that out of the total respondents, 84 (49.7%), 40 (23.7%), and 45 (26.6%) belonged to the 200 level, 300 level, and 400 level, respectively. On the other hand, Table 1 presents the gender distribution, with males comprising the larger proportion (89.9%) of the sample. Additionally, Table 2 shows that the majority of respondents (72.8%) first encountered the term 'sustainable building' during their 'university years.' This finding is reasonable considering their field of study is architecture, and the term likely emerged in some of their core architecture courses.

Surprisingly, a noteworthy proportion (19.5%) of respondents indicated that they were unfamiliar with the term 'sustainable building.' Upon conducting a cross-tabulation analysis (Table 3), it became evident that all of these respondents belonged to the second year (200 level) of their studies. Out of a total of eighty-four (84) 200 level students, thirty-three (33) had never encountered the term 'sustainable building.' This observation can be rationalized by the fact that at this stage (200 level), students are only beginning to delve into architecture-specific courses, and the concept of 'sustainable building' may not have been introduced yet.

**Table 2** First time the term 'sustainable building' was heard (N = 169).

|  | Frequency | Percentage (%) |
|---|---|---|
| Never heard of it | 33 | 19.5 |
| Secondary school years | 13 | 7.7 |
| University years | 123 | 72.8 |
| Primary school years | 0 | 0 |
| At home | 0 | 0 |
| Total | 169 | 100 |

**Table 3** Cross tabulation of students' level and their knowledge of sustainable building (N = 169).

|  | 200 level | 300 level | 400 level |
|---|---|---|---|
| Never heard of it | 33 | 0 | 0 |
| Secondary school years | 7 | 2 | 4 |
| University years | 44 | 38 | 41 |
| Primary school years | 0 | 0 | 0 |
| At home | 0 | 0 | 0 |
| Total | 84 | 40 | 45 |

The demographic data revealed that the majority of respondents are acquainted with the term 'sustainable building,' but it also highlighted a significant percentage of second-year (200 level) students who were unfamiliar with the concept. Among those who were familiar with 'sustainable building,' their exposure to the term predominantly occurred during their university and secondary school years, primarily through school lectures. This emphasizes the importance of introducing sustainability topics to architecture students earlier in their academic journey, as suggested by various authors (Shari and Jaafar, 2006; Ozer et al., 2012; Ashelo, 2014; Allu, 2016; Okon et al., 2021).

*Level of knowledge/awareness of sustainable building*

Respondents were asked to agree or disagree to some statements explaining what a sustainable building is and what a sustainable building can do, and they were asked to express their agreement or disagreement using a scale of 1 to 3 (disagree; indifferent; agree). The outcomes are shown in Figure 2. Notably, a majority of the respondents (59.2%) disagreed with the assertion that a sustainable building is no different from any other ordinary building. This disagreement reflects an understanding of the significant contributions sustainable buildings make to the environment and human life, such as reducing energy consumption, enhancing indoor air quality, and mitigating the risk of sick building syndrome (Sartori and Hestnes, 2007).
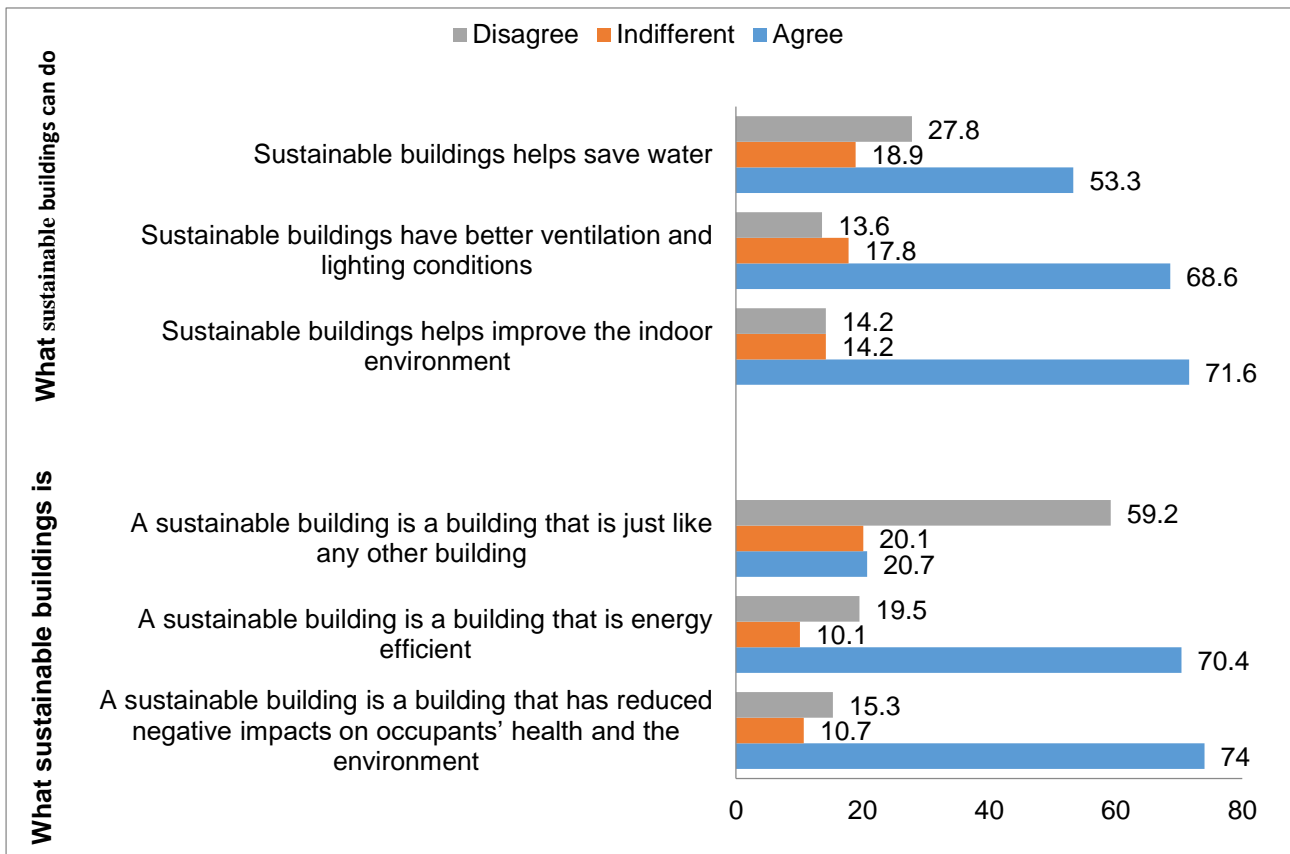
**Figure 2** Respondents' response to what a sustainable building is and what it does.

Additionally, a substantial majority of respondents agreed with the following statements: that sustainable buildings are energy-efficient and have a positive impact on occupants' health and the environment. Moreover, most respondents recognized that sustainable buildings lead to improved indoor spaces (71.6%), offer better ventilation and lighting (68.6%), and contribute to water conservation (53.3%). The findings presented in Figure 2 indicate that the students possess a solid understanding of the characteristics and benefits of sustainable buildings. This contrasts with the results obtained by Alsaati et al. (2020) and Zaki et al. (2016), whose studies revealed that while many participants were familiar with the term "sustainability," their comprehension of its concepts was limited, and only a few truly grasped its implications.

*Application of sustainable building principles in design projects*

Figure 3 to Figure 5 display the frequency at which sustainable building principles are employed in the students' design projects. Figure 3 specifically illustrates the responses related to energy and water usage. Concerning energy usage, a significant percentage of students consistently integrate natural lighting and natural ventilation into their building design projects. This indicates that the students tend to opt for the simplest and most cost-effective approach to achieve energy efficiency in buildings, primarily by providing ample operable windows. It is worth noting that this practice aligns with the prevailing norm in Nigeria, where buildings are commonly designed to heavily rely on natural ventilation and lighting due to the country's inadequate electricity supply.
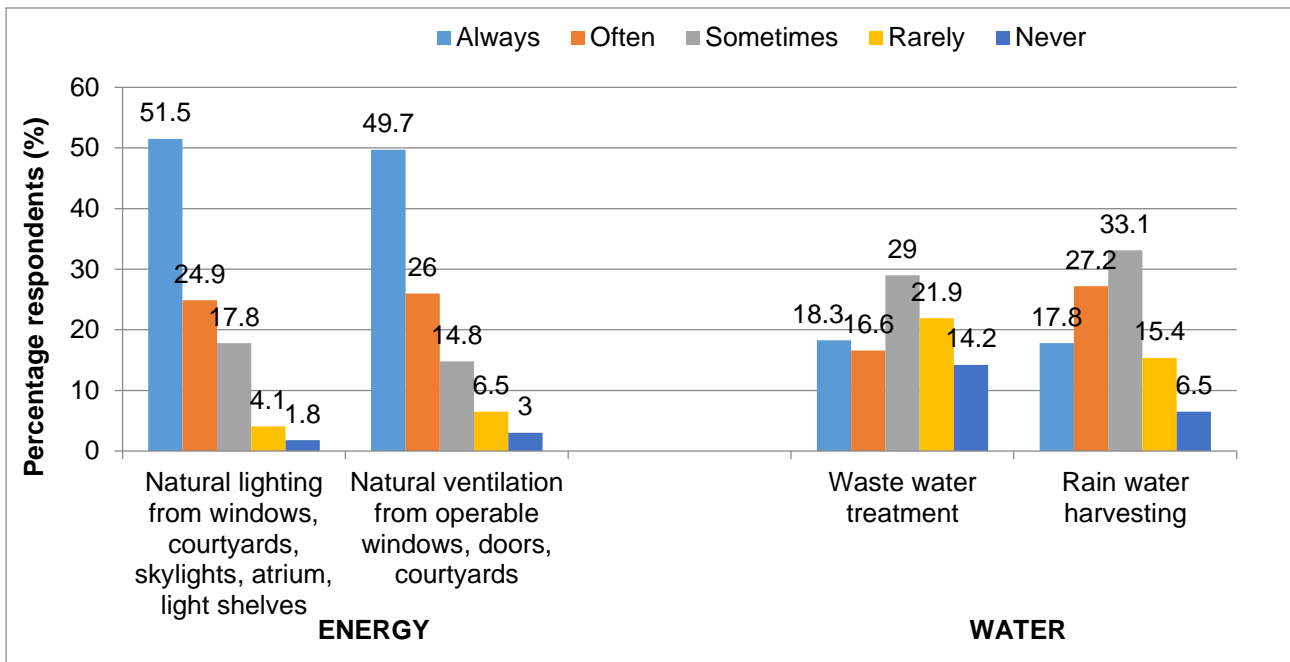
**Figure 3** Sustainable energy and water usage

For water usage, only a small percentage of students consistently consider waste water treatments (18.3%) and rainwater harvesting (17.8%) as methods to conserve and reuse water in their building design projects. This finding is somewhat surprising, given Nigeria's abundant rainfall, which makes it relatively easy and cost-effective to incorporate rainwater collection from building roofs compared to other surfaces. It appears that the students have predominantly focused on the roof's weather protection function rather than recognizing its potential for water conservation. Alternatively, it is possible that the students may have limited knowledge of water conservation, as indicated in the results of Al-Sallal and Alalouch (2018) and Taboada et al. (2020). On the other hand, designing a waste water treatment plant for each design project might pose a challenging task for the students. Moreover, recommending such a facility for individual buildings may not be a practical decision when considering the associated costs.

Figure 4 presents the responses related to material usage in building design and the impact of building design on occupants'

health. It is evident from Figure 4 that the majority of students rarely prioritize the use of sustainable building materials in their design projects.

A small percentage of students consistently consider using recycled materials (12.4%) and locally sourced materials (24.3%) in their building design projects. This suggests that the students may not fully comprehend the benefits and cost implications associated with incorporating recycled and locally sourced sustainable building materials. Encouraging students to utilize locally sourced materials in their designs is crucial. These materials are not only readily available and easily accessible, but they also offer cost-effectiveness and sustainability. By promoting the use of such materials, students can contribute to environmentally friendly building practices while creating more budget-friendly and sustainable designs.
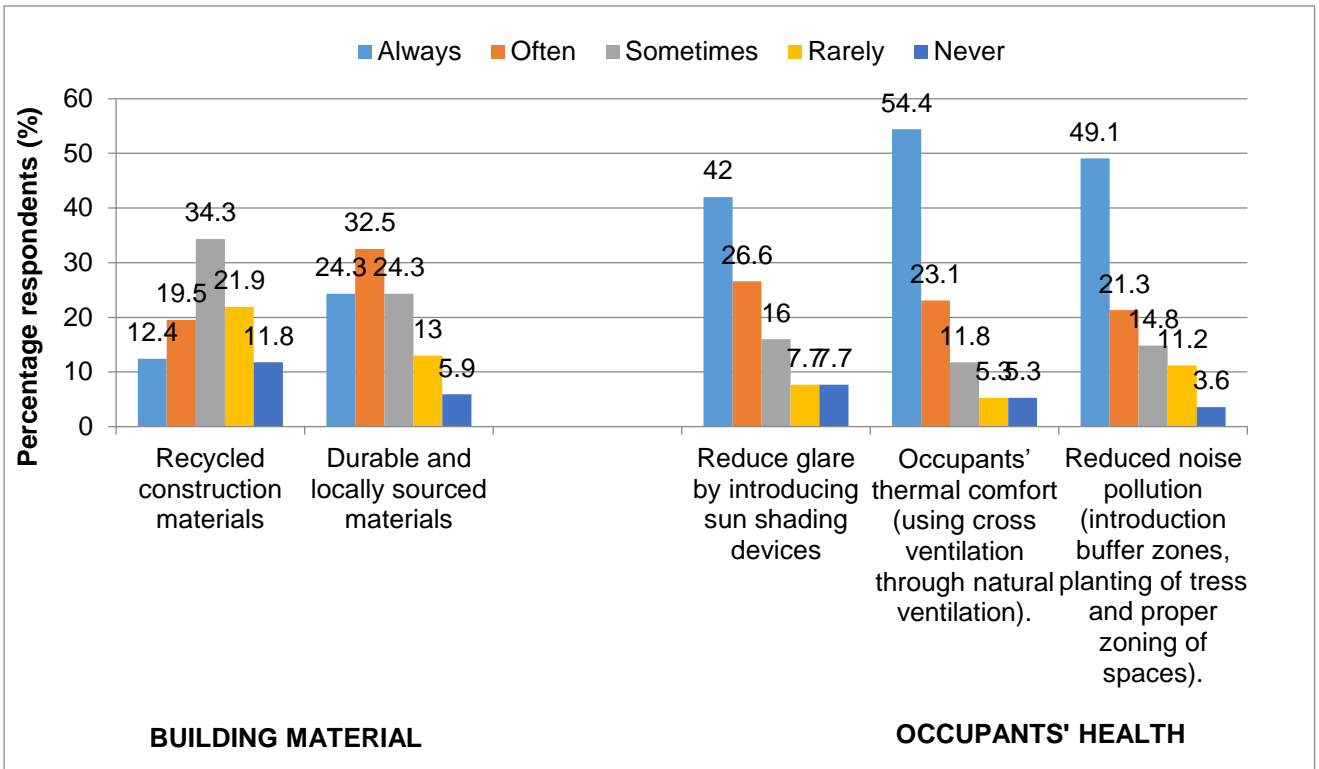
**Figure 4** Sustainable building material usage and Impact of building design on occupants' health

The data in Figure 4 clearly indicates that students are mindful of the potential impact of their building designs on occupants' health. A significant proportion of students consistently take measures to consider glare reduction (42.0%), thermal comfort (54.4%), and noise pollution (49.1%) in their building design projects.

This responsible approach is praiseworthy because neglecting these aspects can lead to severe and often irreversible health consequences for the building's occupants.
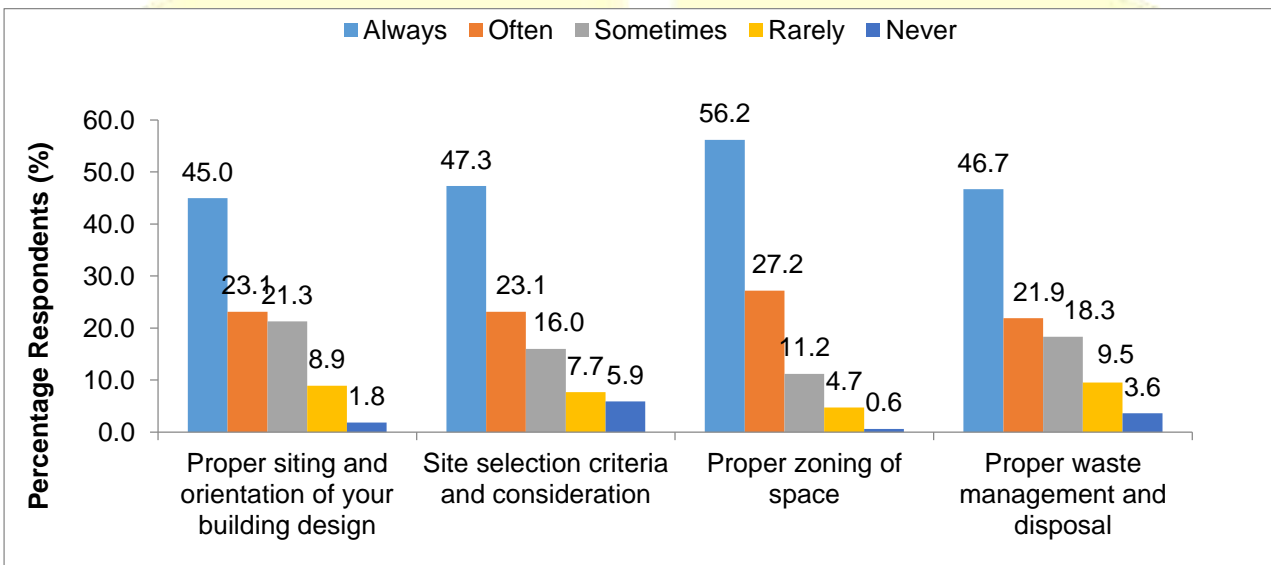


**Figure 5** Impact of building design on the environment

Figure 5 depicts the students' responses regarding the impact of building design on the environment. Similar to their consideration for occupants' health, students demonstrate awareness of how their designs can affect the environment. A significant portion of students (45.0%) consistently take into account the proper siting and orientation of their building designs. Additionally, 47.3% of students always consider the appropriate site selection criteria, 56.2% are consistently conscious of properly zoning their functional spaces, and 46.7% always prioritize proper waste management disposal from their building sites (Figure 5). These findings clearly indicate that the students have the best interests of both the building occupants and the environment at heart.

## CONCLUSION AND RECOMENDATION

This study utilized a questionnaire survey conducted among 169 architecture students at Kaduna State University. Its objective was to examine the awareness and knowledge of building sustainability and the application of sustainable building principles among these students. The findings revealed that a majority of students at lower levels had not heard of the term "building sustainability."

However, senior-level students demonstrated familiarity with the concept, and, in fact, possessed a good understanding of what constitutes a sustainable building and its potential benefits. Regarding the application of sustainable principles in their designs, the results indicated that students were highly conscious of the impact their building designs could have on occupants' health and the environment. Consequently, these factors were given significant consideration in their building design projects. Natural ventilation and lighting

were frequently utilized by students to minimize energy usage. On the other hand, students rarely considered incorporating alternative water sources to promote efficient water usage in buildings, and their attention to using environmentally friendly building materials was low. Sustainable water usage and sustainable building material usage were aspects that received limited attention in their designs.

In conclusion, the students exhibited awareness of sustainable building concepts, particularly among the senior-level students, who displayed a grasp of sustainable building features, importance, and principles. However, despite this awareness, certain sustainable principles were not adequately integrated into their building design projects. Given that this research was limited to architecture students from a single institution, it is recommended that more comprehensive studies be conducted to assess building sustainability awareness among architectural students across universities in Nigeria.

## ACKNOWLEDGEMENT

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# THE REVITALIZATION AND MODERNIZATION OF MANCHURIAN WINDOW OF LINGNAN ARCHITECTURAL DECORATIVE ART

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## ABSTRACT

Regional architecture is characterized by its rich historical and cultural heritage, and decorative art serves as an embodiment of the local spirit, a unique cultural memory, and a symbol of development. Among the diverse architectural styles, the Manchurian window stands out as a distinctive lattice window in Lingnan architecture, representing the fusion of Chinese and Western cultures. As a prominent symbol of modern Lingnan culture, the origin and development of the Manchu window have been influenced by various factors.

This paper adopts a case study approach to explore the historical evolution of Manchurian window. It examines how these windows have undergone changes since the establishment of the People's Republic of China in 1949, particularly focusing on their reuse in traditional settings and their integration into contemporary architectural designs. Additionally, it investigates their incorporation into multidisciplinary innovative designs. The study reveals that the Manchu windows have been integrated with multidisciplinary innovative designs, leading to a fusion of various disciplines. The author hopes that this research will fill the gaps in the study of Manchurian window and provide new insights into the modern application of traditional Chinese architectural decorative art.

*Keywords : Manchurian window, Chinese Lingnan Architecture, modern use*

## INTRODUCTION

In the traditional architecture of the Lingnan region in China, architects often employ a unique form of colorful glass windows known locally as "Manchurian window." These windows boast vibrant colors and diverse patterns, and they originated in the mid-18th century as a fusion of Western glass art with local Lingnan customs and culture, forming a distinctive architectural decorative art. The historical evolution and revitalization of Manchu-style windows can be attributed to three significant factors: Firstly, the traditional craftsmanship of Manchu-style windows has been lost over time, making research on them crucial for the inheritance and development of Lingnan cultural heritage(Mai, 2020). Secondly,

since the establishment of the People's Republic of China in 1949, with the accompanying social changes in China, Manchurian windows have undergone a series of transitions, from decline to reuse and revitalization. Currently, they are widely regarded as a traditional cultural element of the Lingnan region, frequently utilized in the construction of Lingnan-style buildings and local cultural promotional signage. Studying the history of Manchu-style windows enables us to analyze the societal focus and direction on traditional architectural decorative art during different periods, thereby identifying patterns of evolution. Lastly, Manchurian windows represent a unique type of fenestration that encapsulates the ideological development and transformation of the people in the Lingnan region.Researching them can provide insights into the aesthetic tastes of various eras, the psychological state of the constructors, their value orientation, religious beliefs, and more （Gong, 2023）.

Manchurian windows, a distinctive form of fenestration in the traditional architecture of the Lingnan region in China, have a predominant distribution centered around Guangzhou, with presence in other areas such as Foshan, Dongguan, and Macau. These windows are characterized by a rich color palette, including hues of red, yellow, blue, green, purple, and gold. Notably, the use of overlaid colored glass etching and mortise-and-tenon joints represents a significant feature of Manchu-style windows(Liu,2022).In terms of appearance, they can be classified into two types: elongated and square-shaped openings. In the composition of Manchu-style windows, the concepts of " huā xīn " (central theme pattern)and "background" from traditional Chinese painting are borrowed, incorporating the notion of " huā xīn " (central theme pattern). Typically, these central theme patterns feature traditional subjects such as ancient artifacts, Lingnan fruits, calligraphy works, flowers, and plants, all adorned with intricate and diverse decorative patterns( Li & Dai, 2018).

In this paper, the author aims to provide a succinct explanation of the definition and origin of Manchurian windows. Subsequently, an overview of expert opinions and research from different fields related to Manchurian windows will be presented. Drawing from a multidisciplinary approach encompassing history, sociology, aesthetics, and more, the paper will address the process of modernization, evolution, and revitalization of Manchu-style windows. By doing so, it seeks to bridge existing research gaps and provide a comprehensive theoretical basis for the development and study of traditional Lingnan architectural decorative art.

This research endeavors to answer two key questions: firstly, the origin of Manchu-style windows, and secondly, how contemporary designers can revitalize and modernize them. By exploring these aspects, the paper aspires to shed light on the cultural significance and contemporary relevance of Manchu-style windows in the context of Lingnan's architectural heritage.

## Literature Review

Currently, research on Manchu-style windows has primarily focused on their artistic and cultural aspects. A large number of scholars can clearly outline the historical background, conceptual analysis, artistic characteristics （Jiang B,2011 Wu L,2014） . They systematically expounds on how Manchurian windows acquired unique artistic characteristics influenced by diverse cultures. From the perspective of window design, Zhu analyzes the ways in which Manchurian windows blend different cultural elements(Zhu,2019). In terms of craftsmanship and application, Yan introduces the classification and composition of Manchu-style windows and elaborates on the etching process used in their production, providing a theoretical foundation for their construction(Yan ,2021).Zhang examines the colored glass in Yu Yin Shan Fang's Manchurian window and the stained glass in the Cathedral of

the Sacred Heart, analyzing their respective forms and meanings from different perspectives, including craftsmanship, narrative logic, and spatial logic (Zhang,2018).

Moving towards contemporary applications,One noteworthy representative case study of "old things for new use" is Zeng'spaper "Mo Bozhi(Representative of Lingnan Architects) and Garden Restaurants," which introduces the origin and application of Manchurian windows in the design of Beiyuan Restaurant and Panxi Restaurant, both masterpieces of Lingnan architecture by Mo Bozhi (Zeng ,2009) .

Although some research explores the incorporation of Manchu-style windows into modern design elements, such as kite design and furniture design, they lack in-depth analysis of the modernization process and theoretical basis for Manchu-style windows(Wang,2023,Wang2019).
In reviewing the literature on Manchurian window, it becomes evident that there is a rich body of research on their artistry, craftsmanship, and cultural connotations, but a dearth of studies on their reuse, revitalization, and modernization processes. Considering the specific historical context of China, this paper aims to bridge this research gap by focusing on the influence, development, and revitalization of Manchurian window in the post-1949 era, thereby enriching the existing scholarship on this topic.

## Historical Tracing of Manchurian Window

### Origin Analysis

Currently, there are two different views regarding the origin of Manchu-style windows. The majority of scholars believe that Manchu windows originated from a window type commonly used by the Manchu people in Northeast China. According to records in " A Brief History of the Manchus in Guangzhou " in the year

1756, the imperial court dispatched 1,500 Bannermen soldiers of the Manchu Eight Banners to garrison Guangzhou(Zeng, 2012). In order to ensure the purity of their bloodlines and the loyalty of the soldiers, the Manchu garrison in Guangdong retained their traditional customs. They lived in an environment that preserved Manchu traditions and were strictly controlled by the ruling class. From an ethnic perspective, the Manchu people demonstrated a sense of superiority at that time. The characteristic design of window panels in Manchu architecture features large open areas, accommodating the need for better lighting prevalent in the northern regions (Figure 1).
Local wealthy merchants, influenced by a desire for recognition, began to imitate this architectural form as a symbol of higher status. They improved upon traditional Manchu windows, incorporating imported Western colored glass and optimizing the design to suit the Lingnan climate (Figure 2). Gradually, Manchu-style windows became a distinctive regional symbol in the Lingnan area.



**Figure 1:** Image illustrating the characteristic design of window panels in Manchu architecture with large open areas for better lighting .

**Figure 2:** Image depicting the transformation and optimization of traditional Manchu windows, incorporating imported Western colored glass and suiting the Lingnan climate.

Alternative View on the Origin of Manchurian Window: A Historical Exploration from the Perspective of Glass Development

Another perspective on the origin of Manchurian windows comes from the historical development of glass in China. Scholars point out that the history of glassmaking in China can be traced back to pre-Qin times, primarily used for crafting utensils, with very limited use in architecture for flat glass. In the 35th year of the Kangxi reign, a glass factory was established within the Forbidden City, producing glassware for imperial use and optical glass, but there was no production of flat glass. It was during the Yongzheng reign that flat glass began to be used in the Forbidden City(Shui ,2020). However, a significant portion of colored flat glass was still imported from overseas due to the limitations of technology and the difficulty in preserving large materials during long-distance transportation. Therefore, the early Forbidden City could only use small pieces of glass to decorate window openings or assemble small pieces into larger glass windows.

During the development of colored flat glass, these imported goods mainly relied on European tribute, and considering the characteristics of Qing Dynasty's trading ports, the majority of these colored glasses were acquired through Guangzhou Customs and then entered the imperial court. Thus, it is inferred that the term "Manchu-style windows" in Guangzhou should actually be called "Man-Zhou windows," These windows include glass inlays in both the central theme pattern and the surrounding small grid pattern. They are formed by a combination of colored glass and mortise-and-tenon structures (Figure 3).



Step1:Polishing Wooden Window Mullions

Step2:Assembling Window Mullions Based on the Shape of Colored Glass

Step3:Making Window Mullions

Step4:Making Hua Xin Patterns

Step5:Completed Manchu Windows

Step6:Manchu-Style Windows on Lingnan Architecture
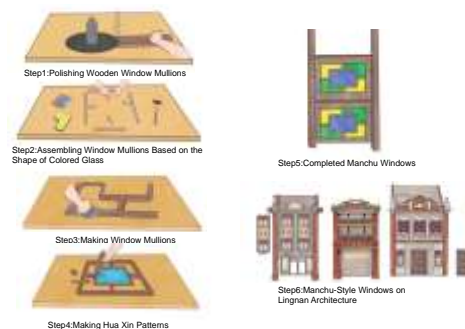
**Figure 3:** Image illustrating the concept of Manchurian window featuring glass inlays in both the central theme pattern and the surrounding small grid pattern, formed by a combination of colored glass and mortise-and-tenon structures

Development Analysis

The origin of Manchurian windows dates back to the mid-18th century when colored glass was first imported from the West. Guangzhou, being an important foreign trade port for the Qing government, had early exposure to colored glass, but it heavily relied on European imports. Later, with the suggestion of missionaries, a glass factory was established in Guangzhou, leading to the shift from complete reliance on European imports to local production of colored glass.

As the etched glass processing technique and pattern design continued to develop and improve, the themes of Manchu-style windows evolved to align more with traditional Chinese aesthetics, incorporating auspicious Chinese motifs. With technological advancements, different intensities of etching and corrosive treatments were applied to various themed images, resulting in a richer range of colors and presenting patterns with shallow relief effects, reminiscent of Chinese painting techniques in etched colored glass. However, due to the expensive cost of materials, etched glass paintings became a symbol of nobility and power, and Manchu-style windows became a representative architectural decorative style in the residences of officials, gentry, and merchants.

Alongside the industrial development in the Lingnan region, the establishment of new glass factories led to a peak in the colored glass industry in Guangzhou during the Republican era. For example, the Chengye Glass Mirror Company had six or seven branches and employed hundreds of people during its heyday. However, in 1919, Dr. Sun Yat-sen proposed and advocated for the establishment of Guangzhou as a "modern residential city" based on Western urban planning ideas in his "Strategy for Building the Nation." This influenced the direction of Manchurian windows in the Lingnan region, gradually shifting the focus from "ornamentation" to "practicality" in their design and application. During this period, a significant number of window styles began to omit the "Huaxin" portion, opting for large areas of solid colored glass blocks instead. This change led to the gradual disappearance of the traditional Manchurian windows' etching techniques from the public eye. In the early years of the People's Republic of China, due to social upheavals and disruptions, the development of Manchu-style windows almost came to a standstill.

## Revival of Manchurian Window

The leading figure in bringing Manchurian windows into modern architecture was the renowned architect, Mr. Mo Bozhi, in the Lingnan region. Despite the tumultuous social conditions of the time, he persistently advocated for the "re-use" and "transplantation" of ancient architectural components, breaking new ground and playing a crucial role in the continuation and development of Manchu-style windows.f colored glass and mortise-and-tenon structures .

In the 1950s, China followed the Soviet Union's idea of "national form, socialist content," emphasizing the ethnic characteristics of architecture. However, by 1953, the first "Five-Year Plan" in China introduced the policy of "increasing production, practicing frugality," advocating for simplicity, authenticity, and easy maintenance in architectural design. Mr. Mo Bozhi's first design incorporating

Manchu-style windows into modern architecture was the North Garden Restaurant, completed in 1957.

The North Garden Restaurant in Guangzhou was a garden-style restaurant design project, and the entire decorative aspect of the design adhered to the concept of reusing old materials. The Manchu-style windows used in the project were collected from abandoned rural areas, where they were going to be used as firewood. The approach taken by Mo Bozhi and his team of "using the old to create something new" was not only an innovative architectural design but also an act of cultural heritage preservation. Considering that the original form of the Manchu-style windows had been largely destroyed, the design team decided to bring them back to Guangzhou and recombine them with old wooden grilles, making them a distinctive "luxury decoration" material for the North Garden Restaurant. The application of Manchurian windows in the North Garden Restaurant was an architectural intervention that seamlessly integrated the windows with the building. Mo Bozhi classified and recombined the patterns and colors of the Manchu-style windows, creating large-scale, block-pattern combinations. This design not only showcased local characteristics but also met the contemporary trend of architectural decorum in being frugal. Most importantly, it paved the way for the incorporation of Manchu-style windows into modern designs (Figures 4).



**Figures 4：** The application of Manchurian windows in modern garden architecture

From 1959 to 1960, Mr. Mo Bozhi's design for Guangzhou Panxi Restaurant placed a

greater emphasis on the artistic quality of "old" Manchurian windows. He extensively collected Manchurian window from the grand residences of Xiguan (the old urban area of Guangzhou), resulting in a richer variety of patterns and exceptional artistic craftsmanship. These windows can be regarded as representative examples of the artistic effects achieved with Manchurian windows. The combination of Manchurian window with traditional wooden carved doors and windows became more mature during this period. The integration primarily focused on extracting the "heart" of the Manchurian window and combining it with traditional woodcarving techniques, which highlighted the delicate and transparent characteristics of the Manchurian windows while also introducing innovative forms(Fu,2016).

Starting from the 1970s, an increasing number of modern buildings began using Manchurian windows as spatial decorative art. Such architectural spaces were mainly concentrated in Cantonese teahouses and restaurants. The unique artistic form of Manchurian windows complemented the teahouse culture of Lingnan (the southern region of China). Additionally, Mr. Mo's extensive use of Manchurian window elements in modern garden-style restaurant designs provided inspiration for other designers. As a result, Manchurian windows were widely selected for screens, partitions, and window panels in the design of numerous teahouses and Cantonese restaurants, thereby highlighting the distinctiveness of Lingnan culture. However, at this stage, Manchurian windows retained their original concept but underwent modernization in their patterns. Geometric combinations became more diverse, and they integrated the ideas of modern designers. Furthermore, the craftsmanship evolved from the traditional etching technique to glass carving and modern glass embossing techniques(Figures5).
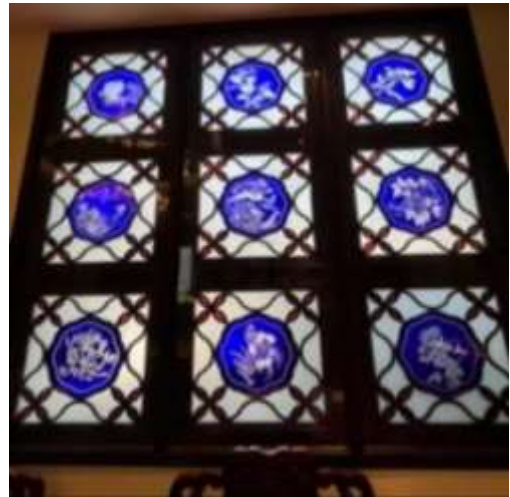


**Figures 5：** The application of Manchurian windows in modern garden architecture

Innovation of Manchurian Window

The innovation of Manchurian windows is rooted in traditional culture and incorporates creativity and new design elements. The allure of culture lies in its diversity, embodying historical and traditional significance, and possessing a unique identity akin to a distinctive mark. By drawing from its historical and traditional meaning and recombining and innovatively transforming it, new visual effects can be achieved. Manchurian windows, as symbols of specific historical and socio-cultural expressions, undergo transformations in form throughout the process of transitioning from tradition to modern innovation (Wang,2019). Through research and investigation, the modern design of Manchurian windows is primarily achieved through continuity of cultural context, stylistic innovations, and cross-disciplinary integration to achieve innovation. The richness of cultural heritage and its ability to inspire creativity contribute to the ongoing evolution and revitalization of Manchurian windows, resulting in their dynamic and enduring presence in modern architectural design.

Cultural Continuity

Cultural continuity is a connected and meaningful development relationship that spans the past and the future. The formation and development of Manchurian windows have been shaped by the

historical and social accumulations, showcasing the profound cultural heritage of the Lingnan region through its unique colors and patterns (Wang, 2021). In modern spaces, the most prevalent application of Manchurian windows can be found in Guangzhou's historic district, Yongqing Lane. Yongqing Lane, located on Enning Road in Guangzhou's Liwan District, is a culturally rich area known for its historical Western-style houses, which were primarily residences of prominent families, officials, and wealthy merchants, extensively decorated with Manchurian windows. However, with rapid urban expansion, the number of preserved Manchurian windows has dramatically declined, and as private properties, they face challenges in effective preservation, leading to the gradual disappearance of this rare local cultural heritage. In order to inherit traditional culture and revitalize the old city of Xiguan, Enning Road fully explores and continues its local cultural heritage, with Manchurian windows as a vital component of its revitalization efforts.

Currently, Yongqing Lane is a popular commercial area and a cultural and leisure destination for young people. In the commercial space designs within Yongqing Lane, the integration of Manchurian window elements is more prevalent with popular dining brands targeted at young audiences. For example, fast-food chains such as KFC and McDonald's incorporate Manchurian window patterns into their sticker designs, effectively and simply expressing cultural continuity while integrating Manchurian windows with their own brand identities, achieving cultural output and fusion. Similarly, the popular tea shop "HeyTea" in Yongqing Lane spontaneously selects Manchurian windows as its thematic element, creating promotional graphics and simplified, streamlined Manchurian window decorations that exude a sense of modernity (Figures 6).



**Figures 6:** Use Manchurian window elements to make McDonald's window clusters

Through such efforts, the continuity of cultural heritage is maintained, and the unique charm of Manchurian windows is made relevant to contemporary contexts, drawing appreciation from both traditional culture enthusiasts and the younger generation. By creatively integrating Manchurian windows into modern spaces and popular venues, the revitalization of this cherished heritage becomes more than just a preservation effort; it becomes a celebration of culture's enduring allure.

Stylistic Innovation and Cross-domain Integration

Stylistic innovation and cross-domain integration can be seen as commercial means aimed at satisfying the public's attachment to history, preserving historical imprints, while also meeting contemporary aesthetic demands. Traditional Manchurian windows primarily feature intricate patterns in the "Huaxin" (central pattern), making it challenging to seamlessly incorporate them into modern designs. As a result, many designers prefer to omit the "Huaxin" and focus solely on the colors and geometric structures for their creative reimaginations.

One of the forms of redesign is the "breaking and reconstructing ", which involves breaking down the original elements and then reassembling them to form a third and distinct structural composition. This process introduces the use of points, lines, and planes to harmoniously relate the elements and

patterns. The overall design process includes breaking away from traditional Manchurian window elements, incorporating modern design language and techniques, recombining colors, lines, and individual components, and finally forming new framing, skeletal structures, and pattern motifs. The result is a breakthrough of the original boundaries, achieving a novel and unique effect in form and content.

An example of cross-domain design representing Manchurian windows is the emblem design for the 2010 Guangzhou Asian Para Games. It draws inspiration from the artistic characteristics of combined Eastern and Western influences in Manchurian windows and conveys the spirit of Guangzhou as an open, inclusive, and innovative city. The emblem's shape

is derived from the upper part of a torch, using the segmented composition of Manchurian windows to depict a silhouette of a person running with their head held high, symbolizing the efforts and self-fulfillment of disabled athletes. The color palette is extracted from Manchurian windows, expressing a joyful and celebratory visual effect. This design showcased Manchurian windows to the world and became a representative example of stylistic innovation in Manchurian window culture. However, in its promotion and description, it was labeled as "Guangzhou colored glass windows" rather than explicitly referring to Manchurian windows, indicating that the general public's understanding of Manchurian windows may still be relatively limited (Figures7).

## CONCLUSION

This research has elucidated the formation and development of Manchurian windows and described the modernization of these windows in terms of their forms, styles, and characteristics after the establishment of New China in 1949. The social changes brought about by the establishment of New China posed significant challenges to the traditional development of Manchurian windows. However, the innovative and bold attempts by designers in the Lingnan region allowed these windows to continue and form a symbol of local identity, blending traditional aesthetics with modern techniques to continue the heritage of Lingnan decorative arts. It can be said that the modern design of Manchurian windows represents a fresh interpretation of the local cultural heritage in the context of modernization, showcasing new approaches to cultural heritage preservation, artistic innovation, and continuity in development. The influence of the times and the process of globalization unavoidably impact traditional aesthetics, and the design of traditional elements must navigate the balance between incorporating new ideas while preserving local cultural identity.

Enhancing designers' understanding of traditional culture and promoting it in the right way are critical considerations for future designs that incorporate traditional cultural elements.

Recommendations:

Designers should deepen their understanding of traditional culture, particularly the history and cultural background of Manchurian windows, in order to better comprehend and carry forward their unique value.

In modern design, designers should fully utilize the elements of Manchurian windows, embracing style innovations and cross-disciplinary integrations to combine these elements with contemporary aesthetics, creating fresh visual effects.

Efforts should be intensified to protect and preserve Manchurian windows, especially those found in historical districts and traditional architecture, to prevent the gradual disappearance of this rare local heritage.

In promoting and propagating Manchurian windows, it is essential to accurately

describe their historical and cultural significance to enhance public awareness and understanding of them.

In conclusion, Manchurian windows, as a unique cultural heritage of the Lingnan region, continue to play an important role in modern design. Through the combination of heritage continuation and contemporary innovation, Manchurian windows have gained new vitality and development in the present day. Nevertheless, to better inherit and promote the unique cultural value of Manchurian windows, continuous efforts are required to strengthen protection and preservation, allowing them to continue to hold significant cultural significance in modern society.

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# FACADE OPENING CLASSIFICATION OF 1850–1930 COLONIAL HOUSES IN SILAY CITY USING GESTALT PRINCIPLES AND FEATURE ANALYSIS

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## ABSTRACT

Due to the 381 years of Spanish and American colonial rule in the Philippines, colonial residential styles—such as those in Silay City—are seen to be complex in language because of the blending of different cultures, contexts, perspectives, materials, and technologies. Therefore, a typological investigation will be performed with the main goal of categorizing the façade openings of selected ancestral houses constructed between 1850 and 1930, which are part of the Silay Historical Protected Site in Negros Occidental. Since doors and windows are key entities that help make the elevation's focal point and visual appeal, the research will classify the visual order of these elements using the gestalt principles. These fundamental façade components are represented by colors so that we can consider them independently and in combination to form the façade. The study will look at how the shape, design, and regional identity of Negrense house facades were influenced by the composition, spatial organization, scale, patterns, ornamentation, and construction technologies utilized throughout the colonial era. In addition, based on their current typological qualities and components, it will provide a chronology and classification system for the numerous architectural façade styles used in the city. Further the findings demonstrates that the materials and technologies brought to Silay throughout the colonial era produced a distinctive element for a particular period, and that each sample made an effort to maintain its own distinctive identity even during the transition between two colonial powers and in contexts in which shared characteristics are also present. Accordingly, the Negrense domestic architecture is thus a product of technological transfer from Spanish and American architecture, but it was built in accordance to changing user requirements.

*Keywords : Colonial residential styles, facade style classification, Gestalt laws, Silay City*

## INTRODUCTION

Silay City, a third-class municipality in Western Visayas with a 2,020.8044-hectare land area, acquired the designation of "Negros' intellectual and cultural hub" due to its collection of historical mansions constructed at the height of the country's sugar industry (The Silay City Government, n.d.). These mansions, where wealthy sugar families once resided, have a significant impact on the socioeconomic and political affairs of Negros and have given distinction to their hometown.

The National Historical Commission of the Philippines also specifies that these houses, which were constructed between 1850 and 1930, are those that date from either the Spanish colonial period, the American colonial period, and/or a mixed historical style and have significant cultural, social, architectural, and artistic value (National Historical

Commission of the Philippines, 2010). These heritage houses are also unique since the majority were not built by professional architects but are rather shaped by 381 years of cultural and technological exchange with foreign traditions and are thus considered as a complex language.

Since the Silay heritage zone was officially declared as National Historical Landmark in 1990, granting its legal protection and conservation, most of the heritage houses on Silay have preserved their historical facades as a conservation priority (Declaring A Portion of Silay City, Negros Occidental, A National Historical Landmark, 1990). New layers have been added to preserve the original components of its architectural heritage, while the old façades have been left intact as part of an ongoing effort to preserve and maintain these colonial houses. Most of them have retained housing as their primary function, but there are some that has already been influenced by changes in land use and no longer correspond to their original type, altering the building interior to fit its current use, which may have resulted in the possible loss of important information about the fabric behind the façade. As far as the façade is concerned, it can be assumed that its properties are preserved to a greater extent in terms of integrity and authenticity.

The investigation conducted in this study focused on the façade of some selected ancestral houses, with doors and windows serving as the primary building components for the elevation analysis. The research will categorize their visual arrangement since these components are significant contributors to the focal point and visual appeal of the elevation (Roa, 1997).

The methodology used in this study is a descriptive qualitative approach that includes categorizing type subsets into chronological order, using gestalt theory (Dak, 2018) to assess the composition, patterns, and construction technologies, and classifying colonial residential façade openings by comparing critical common features across samples using a Venn diagram. These stages for analysis were used to identify the grouping of façade attributes that were prominent for each period. Additionally, colors are used to represent these basic façade elements so they can be considered independently as well as collectively to form the façade.

The four (4) representative samples for this study were chosen based on significant historical periods in the development of Silay City's domestic architecture, from the Spanish *bahay na bato* or literally house of stone through the stylistic development of architectural styles during the American period. All of these buildings, including those in the heritage zone, have tropical elements in their architecture.

In this study, the analysis will assist in improving the accuracy of the seriation, or the chronological ordering of façade openings as architectural components, as well as the method for determining the façade characteristic for each colonial era. Further, the system for classification can even be used to examine the characteristics of colonial-era residences in any location and at any period in architectural history which are important information for historic preservation.

## MAIN RESULTS

The result of the research, with a focus on facade openings, include data relating to visual perception, construction date, materials and technology.

A. Application of Gestalt principles of perception.
1. *Symmetry*
Based on observation and the results of various case studies, colonial houses constructed during the Spanish colonial period had equally placed facade features on both sides of the axis, with a width symmetry frequently made up of two units. The same symmetry is also seen in the colonial houses in Silay that were constructed during the transitional period.
Additionally, while certain houses from the pre-American era may still have symmetric windows, it's important to consider that most of them had an uneven facade symmetry.
2. *Continuity*
Regarding continuity, the facade openings of colonial houses constructed between the Spanish and American periods are vertically and horizontally aligned.
3. *Similarity*
Window elements from the 1850s to the 1900s are classified into two groups based on their size, and spacing and one entrance at the facade provides access to the *zaguan*, or the

space beneath the *bahay na bato*. While the openings that emerged throughout the American era following the transitions offer more variation, in the case of the samples, they have 5 to 7 groupings of facade openings.

| FACADE A | FACADE B | FACADE C | FACADE D |
|---|---|---|---|
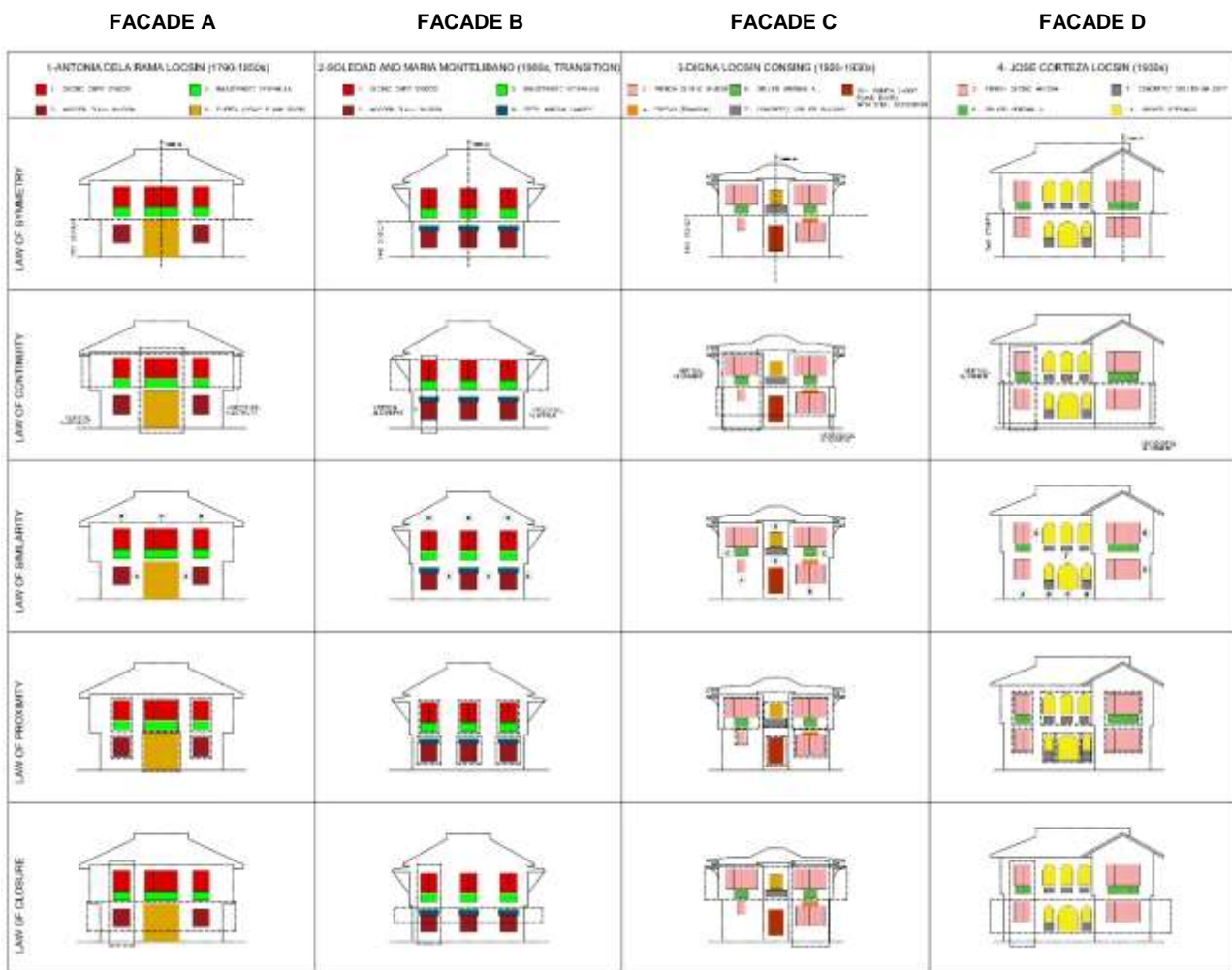


**Figure 1** Analysis of the colonial facade openings using Gestalt laws of symmetry, continuity, similarity, proximity and closure

### 4. Proximity

The Capiz sliding window, balustraded ventanilla and the *puerta* (heavy plank door) are typically combined together to form a *zaguan* in a *bahay na bato*. While the second floor typically has grilled or balustraded ventanilla, a sliding Capiz window and an *espejo* (transom). However, it is important to notice that Facade A, which was built during the Spanish colonial period, doesn't have an e*spejo* or transom window.

### 5. Closure

Regarding closure, irrespective of the historical period, the components of the facade openings do not make a complete line, but the eye automatically links them and recognizes that they are related in part because they may in principle form a line and hence a shape. However, in the instance of Facade C, the small window on the ground floor may call for a different interpretation, but the grouping of the components completes the facade form.

### B. Common features of colonial facade openings

Based on the comparison of common facade features shown in the Venn diagram below, which was inspired from Chan's descriptive approach for style identification (Chan, 2000), the following observations have been generated:

1. The Antonia Dela Rama Locsin ancestral house (Facade A), constructed between 1790 and 1850, and the Soledad and Maria Montelibano Ancestral House, constructed in the 1900s, share three features in common: the sliding capiz window, balustraded ventanilla, and wooden plank window.

2. The Maria Soledad Montelibano

Ancestral House (Facade B) displays components from the American period due of the existence of a steel window canopy (sombrero ng bintana), steel main roof, and secondary roof with steel brackets. While traditional Spanish *bahay na bato* elements, such the ventanilla and sliding Capiz window, are adopted.

3. Facades A and B, however, are distinct from Facades C and D.
4. French sliding windows, grilled ventanilla, and concrete balconies were shared by Jose Corteza Locsin Ancestral House (Facade D) and Digna Consing Locsin (Facade C). These are distinctive characteristics of the American period.
5. Digna Consing Locsin (Facade C) adopted the espejo (transom) from the Spanish colonial era, while Jose Corteza Locsin added distinctive features from the American era, like the addition of a carport and arch openings that connect to the porch and balcony.
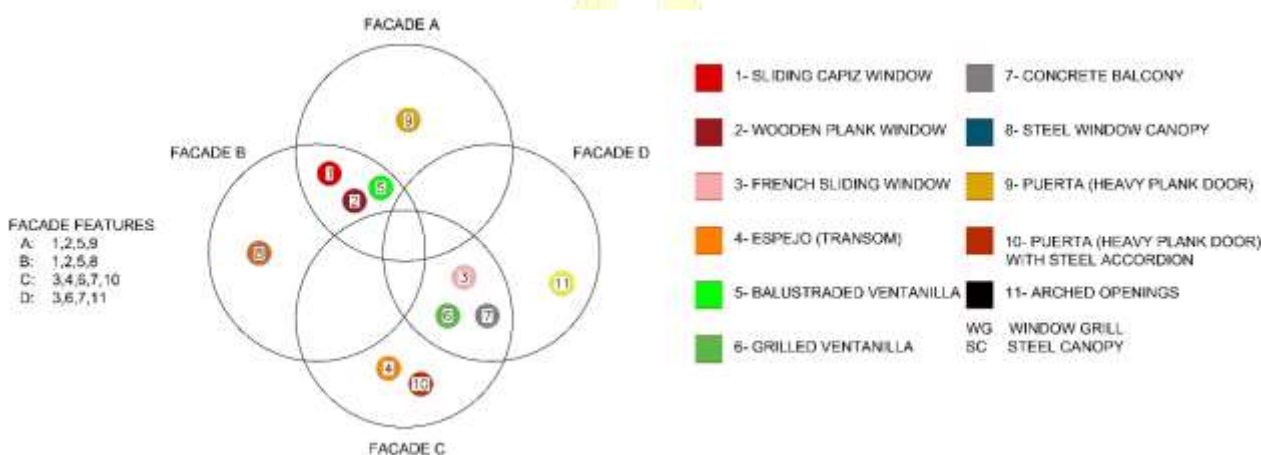


**Figure 2** Venn diagram showing common features and color-coding of facade element

**Table 1** Door and Window Type



LEGEND  S- SPANISH COLONIAL PERIOD  T- TRANSITIONAL PERIOD  A- AMERICAN PERIOD  A$_G$ - AMERICAN PERIOD/ GREAT DEPRESSION

## CONCLUSION

The colonial domestic prototypes of Silay City is influenced by a variety of elements, including climate, building materials, and the period of construction. A mutual feature of these houses includes two storey with facade finish made of local wood. Their standard floor-to-floor height is from 3.5 to 4.5 meters. Both originated in response to the tropical climate of the region.

However, from the turn of the 20th century, architectural reproduction has made use of materials like steel, a primary import from the United States used in both larger structures and residential construction. In Silay City, the similar approach was taken, and corrugated roofing and steel bars were integrated—not only for ornamental purposes but also as a concrete reinforcement. As a result, the facades of certain American colonial homes combine the use of native wood and concrete. Glass windows were also introduced as an alternative to sliding Capiz windows. Later, the wood-and-stone style lost popularity (Consing & Hila, 2018; Lico, 2008).

In conclusion, the colonial facade of Silay City from the 1850s to the 1930s is categorized as having seven (7) variations of window groups and four (4) door types. Meanwhile, the representative samples for each era have a unique identity and may be categorized as belonging to the Spanish, Transitional and American periods of *bahay na bato*, and Art Deco.

In consideration of the façade styles that developed in Silay City, the proposed classification established the historical sequence and groupings of facade openings, which could assist stakeholders and national and local governments in terms of information and conservation.

## ACKNOWLEDGEMENT

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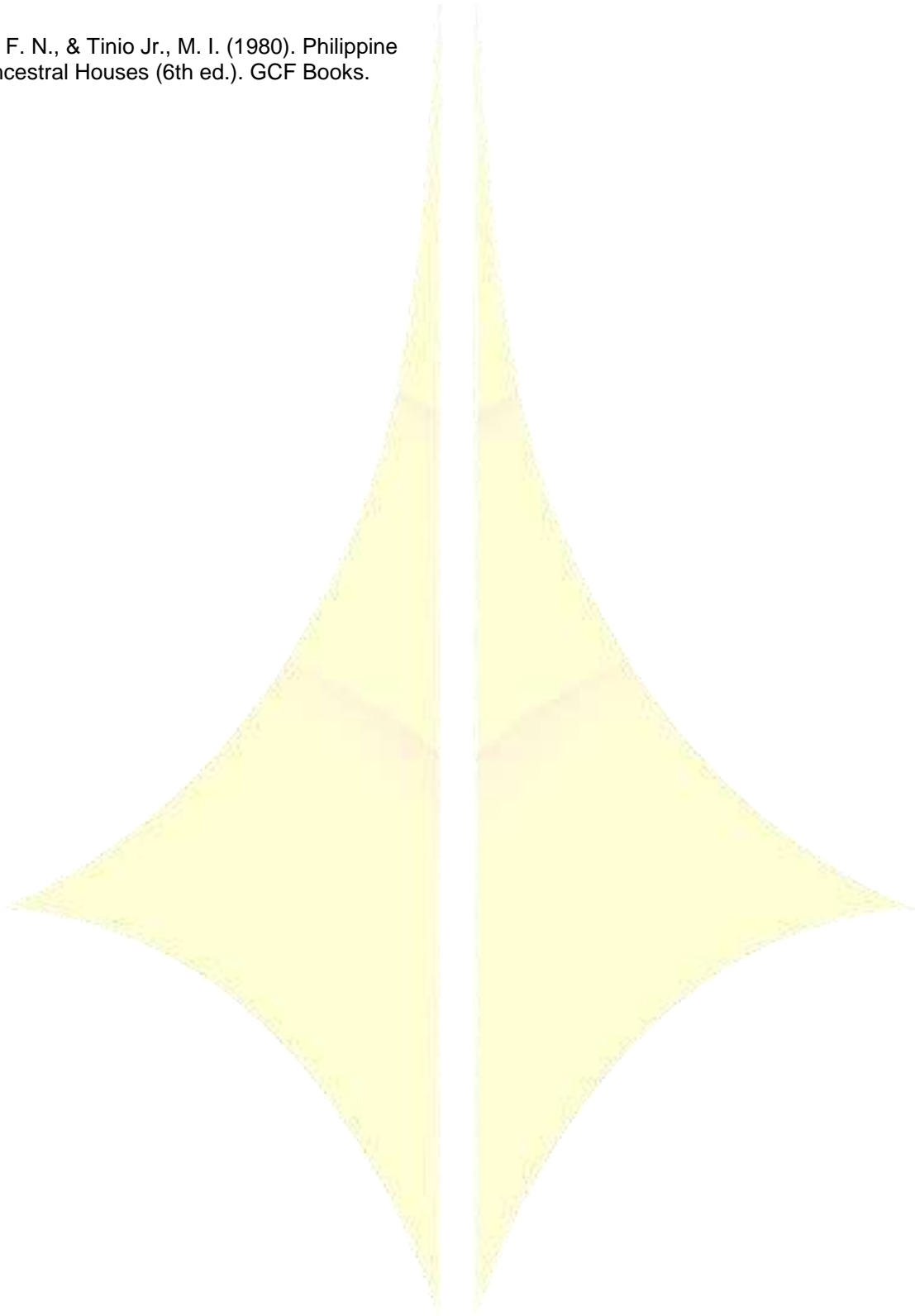
# CRITICAL FACTORS OF BUILDING INFORMATION MODELLING STANDARDS IMPLEMENTATION IN ARCHITECTURAL, ENGINEERING AND CONSTRUCTION INDUSTRY IN SARAWAK, MALAYSIA

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## ABSTRACT

Building Information Modelling (BIM) is a global digital transition in the AEC industry which created both new opportunities and challenges. BIM adoption in Sarawak still remains low. One of the most critical difficulties of implementing BIM is the lack of national BIM guidelines and standards. However, there are several standards and guidelines available in the market but its standardization has become another concern. Therefore, this paper focuses on studying the critical factors that influenced the implementation of BIM standards including its challenges, benefits and success factors, in order to promote and mandate BIM standards in the AEC industry in Sarawak. However, the data collection is limited because this paper focused on Sarawak only. As the standards are still modifying over time, this paper may also be subjected to additional restrictions. Questionnaire survey was adopted to assess the critical barriers, benefits and success factors of BIM standards implementation. IBM SPSS statistic 25 software was adopted for data analysis. The results show that there is a moderate positive relationship between some components among the challenges, benefits, and success factors of BIM standard implementation but the relationship between some components is not very significant. Therefore, it is necessary to investigate the main barriers, benefits and success factors that have a substantial impact on the adoption of BIM standards. The information gathered contributed to the updating of current data on BIM standards awareness and implementation in Sarawak's AEC industry. This research also deepened the knowledge on Sarawak's critical BIM issue: lacking of national BIM guidelines and standards.

*Keywords : Building Information Modelling (BIM), BIM standards, barriers, benefits, success factors*

## INTRODUCTION

The construction software platform has developed from 2D to 3D modelling, and introduced the concept of Building Information Modelling (BIM) in the AEC industry over the last decade (Zaini et al., 2020). Both new opportunities and new limitations are brought by due to the rapid IT-based development (Klein et al., 2022). BIM aims to improve the collaboration and information sharing between different stakeholders in the architects, engineers, and contractors (AEC) industry and the employers by communicating and coordinating the information through a common data environment (The British Standards Institution, 2023).

However, the previous studies revealed that the BIM adoption rate in Sarawak is very low which is about 6% only of the AEC industry in Sabah and Sarawak. The adoption rate of BIM is the second lowest among the core region in Malaysia (Al-Ashmori et al., Myint Naing et al., 2022; Tamjehi et al., 2020).

Despite the low adoption rate, the employers and authorities demand towards BIM is still growing according to the CIDB transformation roadmap and Industrial Revolution 4.0 (Ahlam and Rahim, 2021; Zaini et al., 2020). The Pan Borneo Highway Sarawak (PBHS) is one of the Sarawak projects that adopted BIM and set the benchmark for future infrastructure BIM adoption in Malaysia and throughout the world (Zohari et al., 2019).

One of the challenges of implementing BIM in Sarawak's AEC industry is lacking of national standards and guidelines (Myint Naing et al., 2022; Tamjehi et al., 2020; Zaini et al., 2020). There are many handbooks and guidelines available in the market to assist the BIM implementation such as the ISO 19650 series, National BIM Standard-United States (NBIMS-US), CIDB MyBIM guides, company BIM standards, and so on. However, the diversity of the guidelines and standards due to continuous alteration and amendment has raised another concern which is lacking of standardization of the BIM standards. The development of a standardized BIM standards is critical as the demand for alignment in practice is getting higher (Davies et al., 2017; Zohari et al., 2019).

Therefore, this paper focuses on studying the critical factors that influenced the implementation of BIM standards including its challenges, benefits and success factors, in order to promote and mandate BIM standards in the AEC industry in Sarawak. This paper seeks to contribute to the body of knowledge in this field with the understanding of the current situation on BIM standards awareness and implementation.

## METHODOLOGY

This paper presents a preliminary study based on literature review and a questionnaire survey to obtain feedback from the Sarawak local AEC industry. The method of literature review has been chosen as the secondary data collection to study the benefits, challenges, and success factors of implementing BIM standards. Journal articles, international conference papers, thesis, books, standards and internet-based materials were used for gathering the information and utilized in the questionnaire preparation. Likert-type questions, binary questions and multiple choice questions were incorporated in the questionnaire surveys to enable the respondents to indicate their level of awareness, implementation of BIM standards, and priorities on the major factors that influencing BIM standards implementation.

The sections of the questionnaire are divided as Section A: Background of respondent, Section B: Level of awareness and implementation of BIM and BIM standards, Section C: Barriers of BIM standards implementation, Section D: Benefits of BIM standards implementation, and Section E: Critical success factors of BIM standards implementation. The overall questions of the questionnaire were controlled in 17 questions.

Section A included the information of their current major professions, experience in related fields, and the location where the respondents are working in to keep the study within Sarawak AEC industry which help us to understand the attitude of the AEC industry in Sarawak, Malaysia toward BIM and BIM standards. Single response MCQ is used to obtain information on the respondents' general background.

In Section B, the level of awareness upon BIM and BIM standards is designed in 5-point likert scale, with 1=very low to 5=very high. The binary questions are adopted to understand the condition of BIM and BIM standards implementation in the AEC industry in Sarawak, Malaysia.This section also included multiple response questions to assist the researcher in gaining a better understanding of the references or resources and components of BIM standards that respondents referred to implement BIM.

The Section C, D, and E designed in Thurstone scale which is stated as Most important, Important, Neutral, Less important and Least important to study the level of agreement on the barriers, benefits and critical success factors of BIM standards implementation.

**Table 1** Sections of questionnaire

| Sections | Aim |
|---|---|
| A: Background of respondent | To understand the information of their current major professions, experience in related fields, and the location where the respondents are working in to keep the study within Sarawak AEC industry. |
| B: Level of awareness and implementation of BIM and BIM standards | To understand the level of awareness upon BIM and BIM standards, and the condition of BIM and BIM standards implementation in the AEC industry in Sarawak, Malaysia. |
| C: Barriers of BIM standards implementation | To study the level of agreement on the barriers of BIM standards implementation. |
| D: Benefits of BIM standards implementation | To study the level of agreement on the benefits of BIM standards implementation. |
| E: Critical success factors of BIM standards implementation | To study the level of agreement on the critical success factors of BIM standards implementation. |

IBM SPSS statistic 25 software was adopted for the data analysis such as descriptive, mean and factor analysis to explain facts, find trends, and validate data for interpretation of results.

Cronbach alpha test was used to measure the trustworthiness and reliability of the data. The mean and standard deviation were adopted for statistical analysis. The mean indicated the preference of the respondents and the standard deviation showed the consistency of the data. Spearman correlation test was used to investigate the influence between the variables.

The pilot test received 29 responses from architects/designers, civil and structural engineers, mechanical and electrical engineers and contractors in Sarawak who are involved in BIM workflow as appointing party, lead appointed party and appointed party.

The appointing party who are often the clients, developers, owners or an end user responsible for developing the Project Information Requirements (PIR) and project standards, establishing the Common Data Environment for the project, acting as the primary engine for the BIM project, and being in charge of management changes.

The lead appointed party is usually the lead consultants and contractors who work as a coordinator between the Delivery Team and the Appointing Party responsible for information management and information production.

The appointed parties are often the designers, contractors, suppliers, and vendors who are in charge of producing and delivering their respective information, services, or products assigned by the Lead Appointed Party. When each party's positioning is ready, the responsibilities and tasks for each party are accountable (Construction Industry Development Board Malaysia (CIDB), 2020; Fugas, 2021; Kemp, 2021).

## RESULT AND DISCUSSION

### Cronbach's Alpha

As presented in Table 2, Cronbach's alpha value of BIM standards implementation barriers is 0.770. Cronbach's alpha value of BIM standards implementation benefits are 0.899 as shown in Table 3 and 0.867 for the critical success factors of BIM standards implementation shown in Table 4.

The result indicates that the barriers of BIM standards implementation is moderately acceptable. The benefits and success factors of BIM standards implementation are highly reliable.

**Table 2** Cronbach's alpha value of BIM standards implementation barriers

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of items |
|---|---|---|
| .770 | .771 | 4 |

**Table 3** Cronbach's alpha value of BIM standards implementation benefits

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of items |
|---|---|---|
| .899 | .900 | 6 |

**Table 4** Cronbach's alpha value of BIM standards implementation success factors

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of items |
|---|---|---|
| .867 | .868 | 4 |

## Mean and Standard Deviation

According to Table 5, the highest average of BIM standards implementation barriers is "it is time consuming for document designation to conform with BIM standards" with (SD-0.870). Second is "unclear BIM roles and responsibilities" with (SD-0.882), followed by "the low alignment of BIM standards in the market affects the cooperation in practices" and "there are no national BIM standards to coordinate industry practice" with (SD-0.82 and SD-0.87) respectively.

The benefit of implementing BIM standards with the greatest mean is "BIM standards assist in implementing a simplified and uniform management and BIM workflow" with (SD-0.753), followed by "BIM standards assist in clear roles and responsibilities of delivery team member at different phases of a BIM project" with (SD-0.704). The benefits of "BIM standards assist in standard semantics and ontologies", "BIM standards assist in necessary modifications to organization templates" and "BIM standards help the stakeholders in the learning process" have the same average but different SD which are (SD-0.724, SD-0.772, SD-0.817) respectively. The advantage of "BIM standards help to reflect and address many of the current issues" has the lowest average with (SD-0.689) as shown in Table 6.

Referring to Table 7, the success factor "it is critical that the stakeholders enhance their understanding of BIM standards" has the highest average with (SD-0.817). "National BIM standards must be created based on best practices or common practices adopted by other countries" and "national BIM standards are essential for establishing national priorities" has the same average, ranking second with (SD-0.817 and SD-0.939) respectively. The average for "national BIM standards provide a single BIM standard that can be readily adapted to suit diverse projects" is the lowest with (SD-0.833).

The different mean of the variables reveals the average priorities from the respondents indicating the important factors to implement BIM standards. Secondly, the different consistency of the variables with the same average can be adopted as the second reference for the respondents' preference.

The most critical challenge concerned by the respondents is the time required for the alteration of documents following BIM

standards. The organizations are unaware of the process or appropriate formats to comply with the standards. There are still challenges around organizations' grasp of the BIM process (Bower et al., 2021).

The establishment of BIM standards to assist a simplified and uniform BIM management and workflow gained the most expectation from the respondents. The duplication and overlap reflected the decentralized structure of standards caused the diversity of BIM standards and guidelines (Hosseini et al., 2021; Kumar et al., 2017). However, the standardization of the BIM process is one of the focuses of the development of Malaysian BIM standards (Construction Industry Development Board Malaysia (CIDB), 2017). The ISO BIM standards help the construction teams to adopt a streamlined and consistent approach on information management. This not only benefits the local clients but also the clients with multinational supply chains from a single global strategy because ISO 19650 standards can be adapted in any size and complexity of construction project for the duration of the project's life cycle (Çekin and Seyis, 2020; University of Cambridge, 2023).

The result showed the most critical success factor to implement BIM standards is to raise the awareness of the stakeholders upon BIM standards. It is critical that authorities in both the public and commercial sectors are adopting and enforcing the national BIM standard (Nawari and Sgambelluri, 2010).

**Table 5** Mean and standard deviation of BIM standards implementation barriers

| Variables | Mean | Std. Deviation |
|---|---|---|
| It is time-consuming for document designation to conform with BIM standards. | 3.76 | .872 |
| Unclear BIM roles and responsibilities. | 3.72 | .882 |
| The low alignment of BIM standards in the market affects the cooperation in practices. | 3.62 | .820 |
| There are no national BIM standards to coordinate industry practice. | 3.55 | .870 |

**Table 6** Mean and standard deviation of BIM standards implementation benefits

| Variables | Mean | Std. Deviation |
|---|---|---|
| BIM standards assist in implementing a simplified and uniform approach to information management & BIM workflow. | 4.07 | .753 |
| BIM standards assist in clear roles and responsibilities of Delivery Team Member at different phases of a BIM project. | 3.93 | .704 |
| BIM standards assist in standard semantics and ontologies. | 3.90 | .724 |
| BIM standards assist in necessary modifications to organization templates. | 3.90 | .772 |
| BIM standards help the stakeholders in the learning process. | 3.90 | .817 |
| BIM standards help to reflect and address many of the current issues. | 3.76 | .689 |

**Table 7** Mean and standard deviation of BIM standards implementation success factors

| Variables | Mean | Std. Deviation |
|-----------|------|----------------|
| It is critical that the stakeholders enhance their understanding of BIM standards. | 4.10 | .817 |
| National BIM standards must be created based on best practices or common practices adopted by other countries. | 3.90 | .817 |
| National BIM standards are essential for establishing national priorities. | 3.90 | .939 |
| National BIM standards provide a single BIM | 3.86 | .833 |

## Spearman's Rank Correlation Coefficient

According to Spearman correlation results in Table 8, the barrier of "no national BIM standards to coordinate industry practice" has a moderate magnitude of relationship with "unclear BIM roles and responsibilities", "low alignment of BIM standards in the market affects the cooperation in practices", and "time consuming for document designation to conform with BIM standards". The moderate correlation between "low alignment of BIM standards in the market affects the cooperation in practices" with "time consuming for document designation to conform with BIM standards" is also found.

As shown in Table 9, the advantage of "assisting in implementing a simplified and uniform approach to information management and BIM workflow" shows a high magnitude of relationship with "assisting in necessary modifications to organization templates", and "clear roles and responsibilities of delivery team members at different phases of a BIM project". Strong correlation is also shown between "assisting in necessary modifications to organization templates" and "clear roles and responsibilities of delivery team members at different phases of a BIM project". The benefits of "assisting in standard semantics and ontologies" has strong correlation with "reflect and address many of the current issues", and "help the stakeholders in the learning process".

The benefit of "assisting in implementing a simplified and uniform approach to information management and BIM workflow" has a moderate correlation with "assisting in

standard semantics and ontologies", "reflect and address many of the current issues" and "help the stakeholders in the learning process". "BIM standards assist in clear roles and responsibilities of delivery team members at different phases of a BIM project" demonstrates a moderate magnitude of relationship with "assisting in standard semantics and ontologies". There is also a moderate correlation between "reflect and address many of the current issues" and "help the stakeholders in the learning process".

Referring to Table 10, the success factor of "national BIM standards provide a single BIM standard that can be readily adapted to suit diverse projects" has a strong correlation with "national BIM standards must be created based on best practices or common practices adopted by other countries". "National BIM standards are essential for establishing national priorities" also strongly correlated with "national BIM standards must be created based on best practices or common practices adopted by other countries".

The success factor "it is critical that the stakeholders enhance their understanding of BIM standards" is moderately related to the success factor "national BIM standards must be created based on best practices or common practices adopted by other countries". "National BIM standards are essential for establishing national priorities" and "national BIM standards provide a single BIM standard that can be readily adapted to suit diverse projects" are moderately correlated.

The barriers, benefits and success factors of BIM standard implementation demonstrates a positive relationship between all variables.

However, certain components have a low correlation to each other. Therefore, we can conclude that there is a weak positive correlation among certain components of the barriers, benefits and success factors of BIM standards implementation while both variables tend to increase in response to one another but the relationship is not particularly strong

**Table 8** Code of BIM standards implementation barriers

| Variables | Code |
|---|---|
| It is time-consuming for document designation to conform with BIM standards. | C1 |
| Unclear BIM roles and responsibilities. | C2 |
| The low alignment of BIM standards in the market affects the cooperation in practices. | C3 |
| There are no national BIM standards to coordinate industry practice. | C4 |
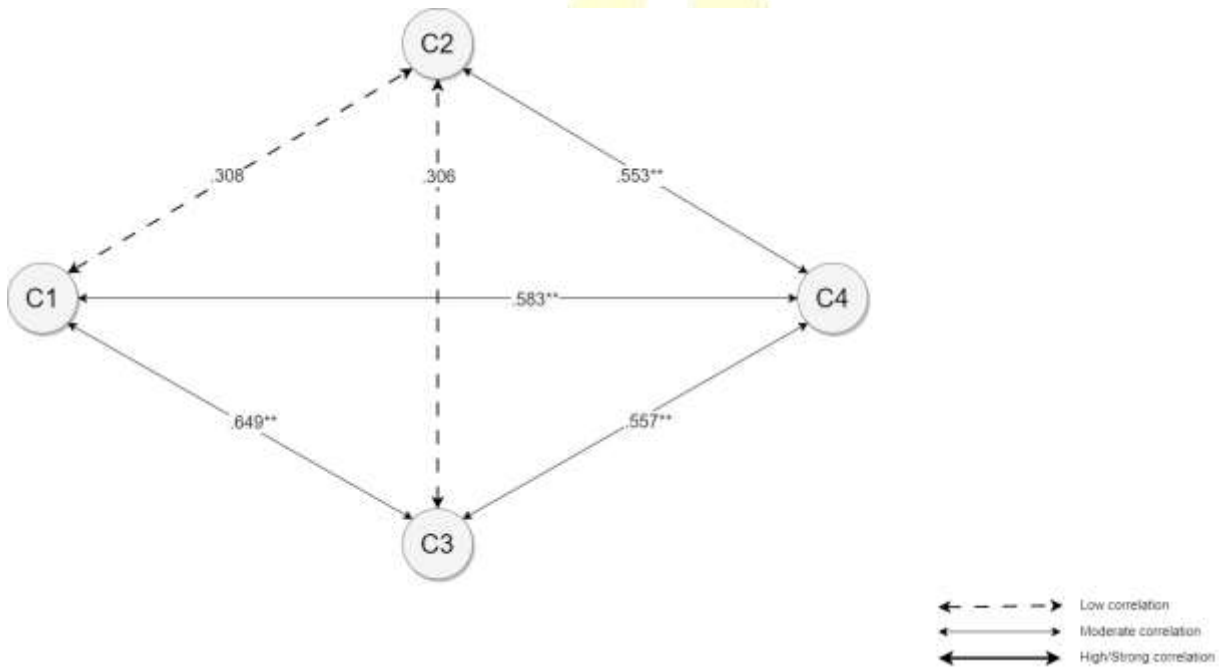


**Figure 1** Spearman correlation result of BIM standards implementation barriers

**Table 9** Code of BIM standards implementation benefits

| Variables | Code |
|---|---|
| BIM standards assist in implementing a simplified and uniform approach to information management & BIM workflow. | B1 |
| BIM standards assist in clear roles and responsibilities of Delivery Team Member at different phases of a BIM project. | B2 |
| BIM standards assist in standard semantics and ontologies. | B3 |

| | |
|---|---|
| BIM standards      assist   in       necessary modifications to organization templates. | B4 |
| BIM standards help the stakeholders in the learning process. | B5 |
| BIM standards help to reflect and address many of the current issues. | B6 |
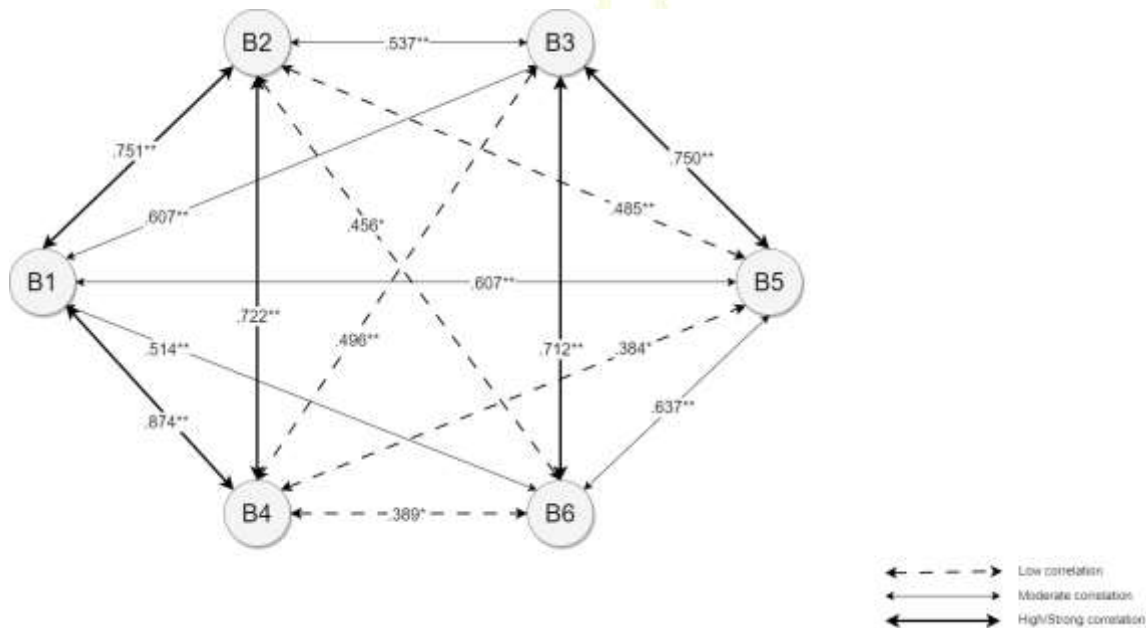


**Figure 2** Spearman correlation result of BIM standards implementation benefits

**Table 10** Code of BIM standards implementation success factors

| Variables | Code |
|---|---|
| It is critical that the stakeholders enhance their understanding of BIM standards. | S1 |
| National BIM standards must be created based on best practices or common practices adopted by other countries. | S2 |
| National BIM standards are essential for establishing national priorities. | S3 |
| National BIM standards provide a single BIM standard that can be readily adapted to suit diverse projects. | S4 |
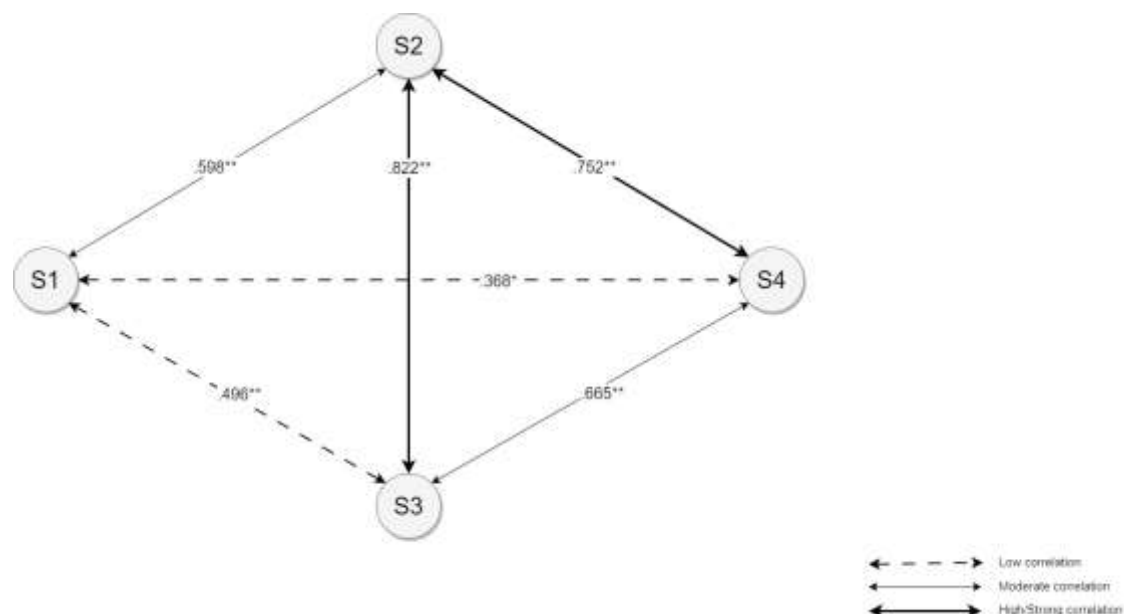
**Figure 3** Spearman correlation result of BIM standards implementation success factors

## CONCLUSION

Due to the increased demand for alignment in practice, the lack of standardization between the available guidelines and standards has become a concern (Davies et al., 2017; Zohari et al., 2019). Therefore, this paper aims to investigate the critical challenges, benefits and success factors that influence the adoption of BIM standards in Sarawak and contribute to the body of knowledge in this field. The data collection is limited in Sarawak only, future research should be expanded to other regions in Malaysia. In conclusion, it is recommended to raise the stakeholders' awareness towards BIM standards in order to promote and mandate its implementation. It is also significant to maintain the compatibility of national BIM standards with other nations. Further research may focus on the challenge of time required for the industry to complete the document designation to comply with the BIM standards and how to work on a streamlined and unified BIM management and workflow.

## ACKNOWLEDGEMENT

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# A REVIEW OF EXTERNAL SHADING DESIGN AND FAÇADE SYSTEMS IN THE BUILT ENVIRONMENT

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## ABSTRACT

Progressive trends in construction technology and design methods has impacted the development of envelopes and components of the built environment initiating a shift from the conventional practice in the industry. Shading systems and their design approach by extension, form a significant aspect of building facades in ensuring adequate conditions of comfort requirements. In view of these and the increasing interest in solar shading system design and research, there seem to be a gap in appropriating the technical nomenclature for the integration of these modern elements. This paper focuses on the design development of complex external shading systems through comprehensive analytic reviews of conventional trends and recent advancements in this research area. The review presented information on respective shape configurations, design elements and operational performance of external shading systems. Consequently, the study suitably classifies shading systems into main and sub-categories to improve design processes in the built environment. Essentially, this paper highlights and compares the efficiency of complex shading systems and their relative significance to functional façade design and development.

*Keywords: Solar shading, Building envelope, Façade design*

## INTRODUCTION

One of the major markers of sustainable performance in the environment include; adequate sun-shading and optimal daylighting (Shum & Zhong, 2022; Hosseini et al., 2019). It is estimated that people spend almost 90% of their time indoors (Mannan & Al-Ghamdi, 2021), and an uncomfortable visual environment has resultant detrimental effects on the occupant (Gaetani, 2019). Likewise, integrating sun shading devices into building facades in tropical climates has many considerable potentials in the context of reducing energy consumption and improving daylight quality (Dalumo & Lim, 2021; De Luca & Dogan, 2019) as opposed to primarily serving aesthetic functions. According to Heidari et al.,

2021), solar shading devices are mechanical devices or textile-based components that can be installed externally, internally or in-between spaces in any type of building. The main objective of the integration of such systems is providing comfortable work places both visually and thermally. Solar shading is a passive design solution that can effectively serve as the sequestration of the building envelope (Kwon et al, 2019). Most high-rise buildings facades, especially those with high window-to-wall ratio (WWR) were designed with ineffective static solar shading systems on the facades, which are proven to be impracticable for its intended purpose throughout the year (Shahdan et al., 2018). The positive effects of sun shading design on the environment of the building envelope are well recognised in tropical climate regions (Nematchoua et al, 2020; Alwetaishi, 2022). Nevertheless, several shading device types "offer different performances for required needs of the occupants in depending on the spatial functions of the building". A functional shading device should shield the envelope from harsh solar radiation impact and also regulate daylight penetration into the building.

Shading devices are renowned features in architecture dating through several historic eras of architecture and building design. Overhangs, colonnades have been employed in different configurations as shading elements on buildings even in traditional architecture. Shading devices form an important element of the building envelope, functioning as a shield from the direct solar radiation to the interior spaces of buildings through fenestrations and large glazed surfaces (Evangelisti et al., 2020). De Luca et al. (2022) pointed out the use of overhangs to shade, provide thermal comfort and establish an aesthetic statement (peculiar identity). Although many shading devices are incorporated merely to serve aesthetic purposes, passive external shading device design on building facades is an essential approach to reduce solar radiation exposure, and to improve the overall well-being of the occupants (Shahdan et al., 2018).

However, same design strategies and configurations are not generic to all scenarios (building types, forms), locations or climatic regions (Mittal et al., 2020) therefore, proper considerations for shading elements should be decided on at the early design stage to determine and integrate the appropriate design for the satisfaction of the shading and daylight requirement of the building.

In recent times, emergent evolution in construction and building technology has enabled substantial improvement in envelope design gradually moving from the conventional style of heavy, fixed members to lightweight, transparent and multi-layered systems. This advancement offers the opportunity for transforming the building envelope into responsive components that can be optimized to accommodate various performance requirement as needed in the environment (Johnsen, 2021).

## REVIEW APPROACH

The article applies an analytical survey to analyze advancements and trends and gives a critical analysis of the existing applications of external shading systems based on data through literature. The study reviewed a wide variety of papers related to the study area and provides an in-depth insight into the elements, parameters and overall design development of shading systems on the building envelope.

## MAIN RESULTS

Freewan (2014; 2015) and Grynning et. al. (2014) outlined various shading devices which can help architects to choose a most suitable device in a particular space, project and design stage. This system depends on the type of design and lighting needs. There are many types of external shading devices, though the most common types assume vertical and horizontal configurations. Conventionally, external shading systems are classified into these two major categories: fixed or

static, and movable or dynamic shading devices (Bellia et al., 2014). Further sub-division into sub-categories are made under these two major categories based on their working operations and configuration when incorporated with building designs. The unconventionalshading types under these two broad categories are also outlined accordingly.

## Static Shading Systems

Static shading devices are designed vertically, horizontally or the combination of both (egg-crate). The benefit of these systems is largely the low maintenance required without additional mechanical systems in operation and their contribution to the reduction of energy consumption especially through the glazed components. Some examples of these are shown in Figure 1. From previous research, vertical shading devices are best suited for east and west facades where there is a reduction in the solar altitude, while horizontal shading devices functions best on facades facing high solar altitudes (Al-Masrani et al., 2018). They

have also been discovered to decrease glare and enhance visual comfort (Li et al. 2020).

Static shading devices can be placed on the building interior or externally, depending on the performance requirement it designed to satisfy. However, based on current trends, it is barely efficient or effective for shading of buildings located in hot climates all year round.

Kirimtat et al. (2016) and Lechner (2014) posited that in terms of orientation, they perform best on the south, east and west orientations but not suitable for buildings where view to the outside from inside is important as they greatly restrict view. Al-Tamimi and Fadzil (2011) also studied the utility performance of external shading devices in boost the number of comfortable hours. The results claim that there is, respectively, an improvement in ventilated and unventilated spaces by 4.7% and 26%. According to this study, the egg-crate shading device is the most effective than other types of shading device design in minimising solar heat gain
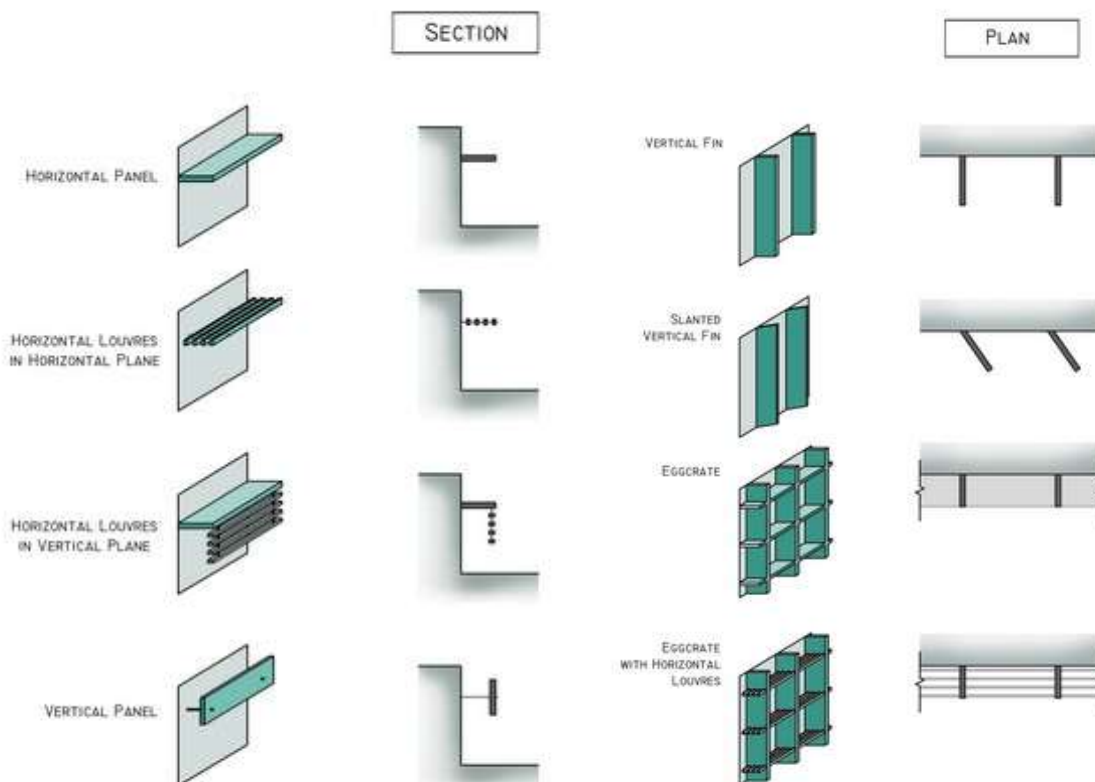


**Figure 1** Static shading systems (Munshi, 2021)

in the weather conditions of the study area. Koc et al. (2021) and Lau et al., (2016), investigated and their results demonstrated that egg-crate shading devices performed effectively annually in a multi-level office building, blocking radiations in hot periods and allowing partial rays in colder temperatures. The main shading types identified by the authors were overhang, side-fin and light-shelves, horizontal and vertical louvers for fixed/adjustable systems, and blinds for adjustable systems. The design of shading devices depends on a variety of factors, which ultimately result in the demand for peculiar designs for every location or orientation.

Static shading systems outside the conventional typologies (vertical, horizontal and egg-crate) can also generate complex geometry on building facades. A survey of contemporary buildings depict that cladding elements can also be designed to produce unconventional shading effects from their shape patterns and formation in relation to the sun movement even though they are not dynamic in operation. As such it is difficult to categorise them into the conventional shading types. Contemporary high-rise buildings show also a trend towards complex curved and shape irregular facade systems. It follows that shading devices must be shapely and functionally more complex.

## Movable Shading Systems

Movable shading devices also referred to as dynamic, kinetic or active shading systems are designed to adapt to user-based needs and the surrounding external conditions. They are developed to be responsive to the evolving environmental conditions such as solar gain, daylighting levels, visibility (Carlucci et al., 2023). An innovation to meet up with current development in technology to salvage human need for comfort throughout the period of occupancy of a space. Movable shading systems attempts to create an equilibrium between allowing optimum daylighting, solar gain control, and giving

the occupant the ability to adjust the working operations of the systems to suit their satisfaction on demand. Hence, movable shading devices, adjustable overhang awnings and rotating fins (Figure 2) are proven to be well suited for virtually all orientations, in terms of shading and view. It is also suggested to be more suitable for buildings in tropical climates for environmental adaptability (Gosztonyi, 2018). These movable systems have been used in building and solar shading design for many years back but usually restricted to internal shading strategies. Due to the limited technology available before now, replicating the movable characteristic of internal shading elements on the exterior of the building envelope remained a challenge.

The 60s and 70s sparked a characteristic enthusiasm for responsive and smart building design and architecture (Kensek et al., 2011; Sharaidin et al., 2012), which can be linked to advancement in architectural computing and technology. The shift brought about an embrace of kinetic forms and dynamism rather than the then conventional practice of static architecture. Zuk (1970), described kinetic architecture as a deliberate practice whereby "building components, or whole buildings, have the capability to adapt to change through kinetics into reversible, deformable, incremental, and mobile modes".

Recent improvements in computational design and digital fabrication, has led to designers innovating methods and techniques of treating the building envelope targeted at solving building design and occupancy challenges (El-Sheikh et al., 2011). Some of these methods are climate-based and flow seamlessly with the surrounding elements of the environment. These methods include the development of kinetic systems capable of geometrically transforming their physical properties in reaction to alteration in environmental elements (Kensek et al., 2011). In the context of research, several existing literatures has conducted extensive

studies ranging from the scope of energy consumption, simulation methods to daylighting. Movable shading systems can be categorised into three major classes according to Joud et al. (2017) namely; dynamic shading systems, smart glazing and integrated renewable energy systems. However, for the purpose of this study, the review shall be limited to only dynamic shading systems classification for building design.



**Figure 2** Manually controlled movable shading devices (Lechner, 2014)

Table 1        Studies on the development of movable shading systems

| Author | Methodology | Tools |
|---|---|---|
| Tabasi & Banihashemi | Design and mechanism of building responsive skins: State-of-the-art and systematic analysis | Literature review |
| Megahead | A conceptual framework for kinetic façade, literature review, comparing existing examples and case studies | Literature review, case study |
| Grobman et al. | Application quantitative methods and tools for dynamic daylighting, Parametric simulation, Case Study analysis. | Case studies, Radiance, Diva |
| Elzeyadi | Comparing the performance of different dynamic shading topologies, Case study and parametric simulations, Development and assessment experimental prototypes of six main shading typologies | Case study, physical measurement, performance simulations |
| Mahmoud & Elghazi | Using parametric simulation for evaluating daylight performance, Parametric simulation method and case studies | Parametric modelling |
| Pesenti et al. | Exploration of existing origami patterns to achieve deployable shading system. | Case study, Parametric modelling |
| Bakker et al. | Explores and quantifies the influence of automated façade operation on user satisfaction | Experimental survey, Case study, Questionnaire survey and Hypothesis testing. |

## Automated Dynamic Shading Systems

Dynamic shading systems or facades can be described as systems employed to bring about reduction in energy consumption of the building envelope (da Silva, 2023). These bring about an adaptability that improves the productivity and comfort of the occupants while decreasing energy expenses and negative

## Folding Shading Systems

One effective way shading using the dynamic shading systems is the folding system (Fiorito et al., 2016). It is basically a shading system that folds to allow or shield sunlight as the need arises. It could be designed in horizontal or vertical, or three-dimensional, depending on the configuration of the geometry, which should be based on its performance

**Figure 3** Folding transformations (Baehr-Bruyère *et al.*, 2014; Kretzer *et al.*, 2012)

impact on the environment (Wigginton et al., 2013; Schumacher et al, 2012). Shading devices can also be appropriately controlled (Dubois, 2001; Tzempelikos et al., 2010) depending on the expectations of the occupants and the associated needs (glare control/ privacy/ overheating). Reacting dynamically to changing environmental conditions (sun-path), shading systems modify the building envelope to the season and the occupants' varying needs, simultaneously balancing the energy load of the building (Tabadkani et al., 2021; Eltaweel & Su, 2017). The control of operating the systems can be regulated using timers or sensors detecting for instance the wind speed, solar irradiance or the luminance levels.

The dynamic facades are technologically developed based on transformation mechanisms by folding, sliding, rotating, shrinking or expanding when activated (Asefi, 2010; Moloney, 2011). With the integration of dynamic shading devices, it is possible to attain a balance of adequate daylight requirement and less restricted view for the occupants.

requirement. The system consists of sensors capable of analysing change in its external environment (sensors) and exchanging the data to the "actuator" (Addington et al., 2012) which causes a variation in the properties of the shading system. This shape transformation application in buildings is a result of several experimentations on the folding Origami geometries in architecture (Kheira et al., 2017).

Folding shading systems have two types of movement when applied on buildings upon installation as illustrated in Figure 3. In both cases, the device system reacts to the changing external conditions such as temperature, utilising minimal energy in the process (Sun et al., 2012). An actuator which is an essential component of the system, can either be embedded in the device or placed in a vantage position activate its responses. The first form of movement adopted by designers in folding systems is the translational typology which operates a bi-dimensional transformation by aperture variation movements and overlapping layers. Another movement

type observed in designing folding shading systems is the three-dimensional transformation and capable of swivel motion on the same as well as a different axis.

## Building Application Examples

*School Building University of Potsdam Germany*
This building designed by the German architectural firm Böge Lindner Architekten, Hamburg (Ellise, 2019). The building is located in a temperate climate zone and its envelope is made up of a gold coloured aluminium facade comprising 535 facade elements with a total area of 1225 m² attached to all four sides of the building.

climate responsiveness and pleasing aesthetics. The twin-29 storeyed towers located in the hot desert climate city of Abu Dhabi, embraced the symbolic hexagonal Mashrabiya design (Alotaibi, 2015) illustrated in Figure 5; a shading system based on lattice screen structures peculiar to Arab countries which was subsequently developed to folding triangular shading panels embedded with kinetic technology that initiates a folding and unfolding reaction to the movement of the sun with the intent to shield the envelope.

This innovative design resulted in tackling the challenge of critical exposure of large building façade areas to high levels of solar radiation experienced in the region. According to Selkowitz (2003), about 50%



**Figure 4** Building facades showing application of folding shading device system (Ellise, 2019)

The position of the panels depends on the position of the sun and the individual occupants shading requirements (when manually controlled), giving a constantly dynamic façade which improves the aesthetic of the building. When open, this system enables cantilevered sun protection which is useful especially on summer days when the sun is high in the sky, and which enables the view to the outside to be entirely unobstructed in addition to reduced direct radiation and glare from sunlight. Figure 4 shows views of the building application of dynamic shading systems

*Al Bahar Towers UAE*
This is one of the popular design innovations in the context of shading building facades with consideration for

reduction in energy consumption and carbon emissions was achieved by integrating the shading system, which is a considerably huge achievement in energy conservation when put in comparison with similar buildings located in the region. Figure 6 shows exterior views of the towers and the operation of the shading system.

## Rotating Shading Systems

According to Orsi (2009), these are simply shading devices designed to rotate about an axis in a vertical or horizontal direction depending on its panel position. They are made up of different materials including fabric, glass, timber and metal louvers. Different shape and form configurations can also be functionally derived with
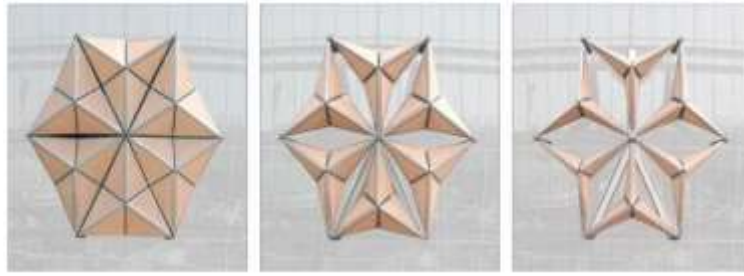
**Figure 5** Mashrabiya panel folding mechanism for shading (Alotaibi, 2015)



(a)                                    (b)

**Figure 6** Full integration of the dynamic shading system on the towers as seen at (a) daytime and (b) night time (Cilento, 2012)

rotating shading systems at different angles of inclination. Studies show that rotating shading systems offer significant reduction in energy use of office buildings on the four cardinal orientations in hot humid climates. Hammad (2010), recorded energy reductions of 30% using dynamic panels inclined at -20° on the south orientation, as well as 34% and 29% savings on the east and west orientations respectively at an inclination of 20°. Kensek et al. (2011) also realised about 30% reductions in heating and cooling loads from overhang horizontal panels in a hot climate zone. The design of the rotating shading system is essentially based on the carrier system which vary and dependent on the type of application, louver size and its span (Kheira et al., 2017).

## Building Application Examples

*Q1 Headquarters Germany*
The Essen multi-storey office building made up of 10 floors was the first of its kind to attain the highest sustainability certification in Germany for meeting up with the green building design standards especially in its sustainable heating and cooling strategies in a temperate climate. One of these strategies is the adoption of rotating dynamic sunshades in the façade design as shown in Figure 7. The rotating shading system consists of over 400,000 units of "feather-like" steel panels which moves vertically in the same direction as the sun position to shade the building interior spaces from recurring heat gain and also improve natural lighting conditions (JSWD ARCHITEKTEN, 2014). The integration of the shading façade

Figure 7 Q1 Headquarters, Essen (a) Exterior view (b) Shading panels on facade (JSWD ARCHITEKTEN, 2014)

coupled with other energy efficient strategies brought about a low energy consumption rate of less than 150kWh/m2 annually.

*Council House 2 Australia*

Similar to the Q1 building, Council House 2 (CH2) located in Melbourne- a temperate zone, is the premier certified green building in Australia (Hes et al., 2005). It is an exclusive multi-storey office building with a double skin façade shaded with kinetic shutter panels that responds to counter direct radiation from the sun's positions through the day, as seen in Figure 8.

indoor environment in terms of their general well-being (Alotaibi, 2015). The solar tracking operation of the shading system ensures over 95% of the building facades are shaded during the day, and overall delivers 82% savings in electricity loads and 87% reduction in carbon emissions annually (Hoogland et al., 2013).

## Control of Dynamic Shading Systems

Dynamic shading devices can be controlled by manual (user) or automatic strategies. From the review of related literature, the adoption of automatic



Figure 8 Council House 2 Building (a) Exterior view (b) Shading panels (Snape, 2013)

Evaluation of the building after completion shows an increase in workers' productivity by 11% and 80% of the occupants indicated a positive perception of the

controls for solar responsive and sustainable building approaches as it applies to external dynamic shading design trumped manual controls. Table 2 shows a summary of the control strategies

in the building application examples discussed earlier.

## Automatic Control Strategies

Actuators and sensors are materials that form a significant part of the dynamic shading systems (Sobczyk et al., 2022; Shchegolkov et al., 2021). Due to the technology involved in their development they are often referred to as smart materials. Smart materials are basically stimulus responsive materials (SRMs) which are the most appropriate materials for dynamic solar facades (Balali & Valipour, 2020).

2021). Active loop controls are usually employed in buildings for this purpose to open and close the shading devices for smooth motion of the shading parts daily (Sterl and Mahdavi, 2022).

Furthermore, the automatic control of shading devices is centred on three types of control algorithms depending on the performance requirement to be addressed (Solis-Cisneros et al., 2022). Sun blocking controllers operate based on algorithmic adjustment of the slat angle or position of shading device in reference to the position of the sun. Threshold controllers: ensure the activation of the shading device when the solar irradiance or illuminance limit is

**Table 2** Control strategies for dynamic facades

| Building | Climate | Building use | Control method | |
| --- | --- | --- | --- | --- |
| | | | *Automatic* | *Manual* |
| *Al Bahar Towers* | Hot sub-tropical/ Desert | Office | ● | |
| *University of Potsdam* | Temperate/ Humid continental | Education | ● | ● |
| *Q1 Headquarters (JSWD* | Temperate/ Humid continental | Office | ● | |
| *Council House 2* | Temperate/ Oceanic | Office | ● | |

The automatic control of dynamic shading is made possible by devices known as actuators or "movers" in simple terms. It is the electro-mechanical component of shading systems responsible for moving parts of the shading elements based on programmed input prompts or energy sources efficiently (Sobczyk et al., 2022).

Actuators move objects in two basic forms of motion namely: linear and rotary motions. Linear actuators result into simple straight-line movements while the rotary variant provides revolving movements of target objects in different configurations (Stroud & Hartl, 2020). Using actuators and sensors to control the movement and transformation of dynamic shading devices poses significant advantages in the adapting the system to the underlying external environmental conditions. The automation of the actuators can be defined using open or closed loop control systems (Minzu et al.,

exceeded, and lastly mode and scene controllers.

## Complex Shading Systems

Shading systems can be created and developed such that its layout, configuration and motion relative to the building envelope generates shading effect outside the conventional shading systems (Scaheaffer & Vogt, 2020). Advanced design and manufacturing technologies have made the development of atypical and novel design components possible in many ways to support sustainable building development especially in the aspects of climate-responsive architecture. To achieve the responsive nature of the system, the materials have to be malleable and flexible structurally thus, most of the complex typologies on the building envelope are referred to as skin systems. This property of the shading elements enables

designers produce aesthetic and functional geometries for building facades. However, because of the almost cognate visual typology of façade skins, there are often common misconceptions surrounding the appropriate nomenclature and evaluation of the effects of these shading systems. Detailed categorization of complex shading systems is discussed below.

As stated earlier, complex shading skins are quite similar in appearance and often difficult to distinguish. Hence, this categorization is based on their base geometries. The first and basic form in this category is the louver system which consists of vertical or horizontal panels that can revolve about their longitudinal axes (Eltaweel et al., 2021; Panya et al., 2020; Tabadkani et al., 2020). The second is deployable system which morphs its shape based on pre-programmed energy triggers. Since the innovation of deployable elements, it has developed to take the form of several configurations but broadly classified into three subsystems which includes lattice, continuous and pneumatic. The lattice typologies (scissor-like and tensegrity) are basically systems made up of interconnected distinct non-planar components. (Asefi and Shoaee, 2018; Chang et al., 2019).

The second deployable subsystem is the continuous typology is the opposite of the lattice system. It is made up of It is comprised of flat components with no visible joints of any type. The origami and kirigami system, which is the first subset of the continuous subsystem, was influenced by the Japanese craft of origami and consists of stiffly pleated panels (Tabadkani and Valinejadshoubi, 2020; Samuelsson and Vestlund, 2015). The last subsystem of the deployable systems is the pneumatic typlogy which is a tensile structure that uses heated air inside of an assembly and is sustained by pressure differences on both its interior and exterior sides. (Albag et al., 2020; Shi et al., 2019). The third category is the membrane system, is constructed from a lightweight, malleable, organic or synthetic material. They all structurally make up a form-active tension system. (Yoon, 2021). The Lamella system is made up of an overlapping series of parallel, generally small components that are riveted altogether to generate an ovoid pattern. (Kontovourkis et al., 2013; Tamke et al., 2010). The last category is the truss system which is a configuration of shafts in the form of a triangle that renders the system functional under both compression and tension forces. (Gupta et al., 2020; Lianto et al., 2018).
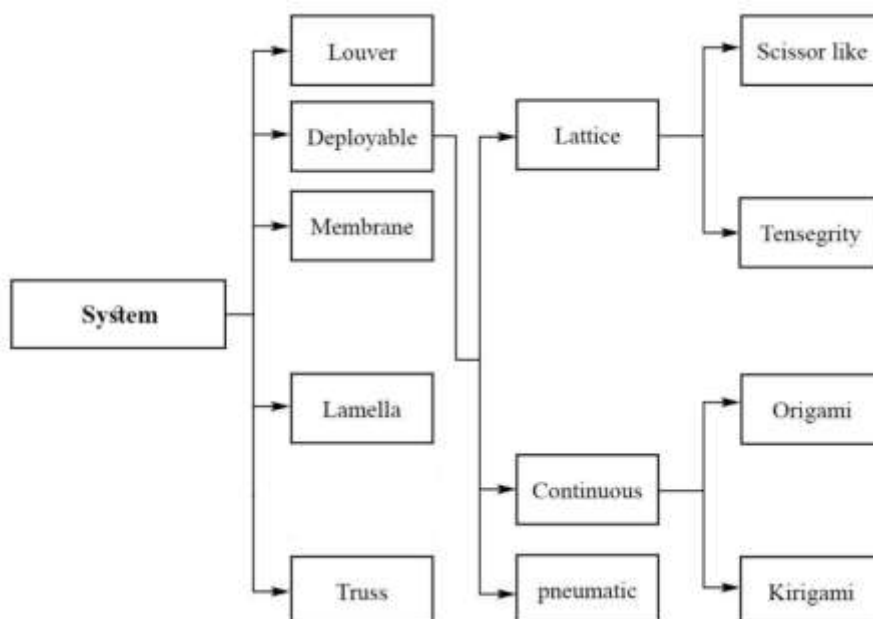


**Figure 9** Complex shading system categorization.

From the papers reviewed, the louver and deployable systems (lattice) appear to be the commonly used on building facades. This is because they are less complicated in design and manufacturing, they are also quite flexible in application to facades to satisfy design requirements in practice. The inspiration of continuous systems is derived from heritage-based arts thus, its application is quite limited to particular regions and building types. Research into the adaptation of pneumatic and other categories of complex shading systems is growing nonetheless, still at an exploratory stage for designers. However, there are several digital tools available to support their efficient development.

## CONCLUSION

This paper has reviewed the different shading system design and development and their application in the built environment in recent times. Shading devices do not only shield sunlight from building interiors, but perform a significant function in channelling indirect daylight into deep spaces, eliminating glare and preventing direct sun infiltration. Therefore, shading device design-related considerations should be made to optimally adapt to the climate of the location. In modern architecture, multi-storey offices are conventionally designed with glazed curtain wall systems which allows considerable amount of direct solar penetration through radiation into workspaces, consequently affecting the indoor environmental quality negatively. The shading device systems reviewed highlighted and discussed the design and working principles as well as the conditions where their application are best suited for according to previous studies.

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# THE COMPATIBLE ANALYSIS OF EXISTING INFILL BUILDINGS' FAÇADE DESIGN IN GEORGE TOWN HISTORICAL COMMERICAL PRECINCT

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## ABSTRACT

The urban historical district is one of the places that possess strong genius loci due to its continuity and distinctiveness qualities in their architectural heritage design especially through the building façades. In Malaysia, the urban historical districts significantly refer to George Town and Melaka. However, the historical character and values of these places are constantly pressured by the infill building façade which is designed contrary to the surrounding context in the district which elicited anxiety on the historic character and values deterioration. Thus, using the qualitative research method, this paper aims to evaluate the existing infill buildings' façade design in George Town's historical commercial district by utilizing the compatible analysis. The field observation works were conducted to collect the data and organised it into a three-dimensional model, a two-dimensional image view of building facades and a table of the building background data forms. Through the visual analysis technique, the spatial and visual attributes of the existing infill buildings were evaluated. In the spatial attributes, the façade design of the existing infill buildings was only compatible with its surrounding context in terms of the building organisation but not in the building height and street enclosure ratio. In the visual attributes, the façade design only compatible to the four sub-attributes including the whole shape articulation, the façade ratio, building material used and colours. However, it is against the attributes of sub-unit façade shape articulation, all large-scale cues, and the façade ornamentation character of the district. Thus, the incompatible of infill building façade design has resulted in the deterioration of the urban historic district character and its historic values.

*Keywords: Infill building, Façade design, Urban historic district, George Town, Compatible analysis*

## INTRODUCTION

Urban historic district is one of the places that have strong genius loci (Baper, 2018; Azmi et al., 2017; Sabah & Abdul Samad, 2016; Ismail & Shamsuddin, 2005). Genius loci can be defined as a spirit of place which is the totality of the place attributes in constructing the identity of place (Schulz, 1979). It is the mutual relationship interaction result between the place and its inhabitant. On the other hand, in an urban area, Ujang (2012), Shamsuddin (2011) and Lewicka (2008) illustrate it as the urban identity which is a

set of place attributes in an urban area that express the quality of continuity and distinctiveness. Furthermore, heritage building or known as the architectural heritage through its architectural design is one of the significant physical components that contribute to the urban identity construct (Baper, 2018; Shamsuddin, 2011; Brolin, 1980). Soosani (2013) and Semes (2009) argue that heritage buildings construct the urban historic districts through spatial and visual attributes. Spatial attributes comprise the building sitting, building mass form as well as the scale proportion and its interrelation with the urban and street pattern and the urban spaces. Meanwhile, the visual attributes are set by façade and roof design that contribute to forming the urban scape. Meanings that, parallel to Schulz (1979) and architectural identity of the heritage buildings is the core thing in the constitution of urban heritage district's identity.

In Malaysia, the prominent urban historic districts usually refer to the old commercial area of George Town and Melaka due to their UNESCO world heritage site status and outstanding value of cultural heritage. Despite that, there are many other urban historic districts such as Kuala Lumpur, Ipoh, Taiping, Muar, and Johor Bahru which also have a significant urban identity (Shamsuddin, 2011). Moreover, Ujang (2012) highlights that those historic districts are the architectural manifestation of multicultural layers over time. In these urban historic districts, there are many heritage buildings with identical architectural features that have resided in the area for more than 100 years. Although there are many monumental heritage buildings in urban historic districts, heritage shophouse is the main heritage building type that significantly has characterised the urban historic districts. It is due to its distinctive architectural design on its building façade and building organization that is set in the form of clusters and reflects its community's lifestyle over time (Ali et al., 2015; Elnokaly & Wong, 2015; Chiong, 2014). Thus, this phenomenon has made the urban historic

districts in Malaysia the heritage shophouse district (Zamri et al., 2023a). Although there are many heritage shophouse styles that morphologically developed over time in urban historic districts, their architectural design juxtaposition to the neighbouring units is found harmoniously fit to each other and constitutes a unique townscape and urban identity (Shamsuddin, 2011; Ismail, 2016; Zwain & Bahauddin, 2018).

Despite that, these heritage shophouse districts are continuing to be developed where many new modern buildings were erected in between the existing heritage buildings within the district especially after the independence of Malaysia (Shamsuddin, 2011; Chen, 2007). To continue, a review of many old towns' local authority's development plan documents has found that infill building is defined as a new modern building with no heritage significant value either built on the empty infill building lots or replacing the existing old buildings (Majlis Bandaraya Melaka Bersejarah, n.d; Majlis Bandaraya Pulau Pinang, 2016, Majlis Bandaraya Ipoh, 2023; Dewan Bandaraya Kuala Lumpur, 2023). Moreover, the replacement building type also could be classified as an infill building which is already built in their place (Majlis Bandaraya Pulau Pinang, 2016). Furthermore, the historical character of these urban historic districts started getting pressure when these new buildings' architectural design is proposed in contrast to the existing urban's historical character (Zakariya et al., 2015; Said et al. 2013; Shamsuddin, 2011) specifically on the façade design (Zamri et al., 2023b). Thus, this phenomenon has elicited anxiety about the historic districts' character and its value deterioration over the different architectural design convergence of the new buildings' façade design. Therefore, the objective of this research is to evaluate the existing infill buildings' façade compatibility fitness to the neighbouring heritage building units, especially the heritage shophouses. Using the case study method, the study was conducted in George Town's historic commercial district due to the domination

of heritage shophouses, its UNESCO world heritage site status, the significance of the architectural attributes and development history as well as the new modern building development phenomenon.



**Figure 1** The case study area within George Town UNESCO core zone. (Source: the final draft of George Town UNESCO world heritage site special area plan 2022)

## LITERATURE REVIEW

a) Heritage Shophouses Architectural Design.

Heritage shophouse is commonly known as a mix-used heritage building type in Malaysia where it combines the commercial on the ground floor and the residential programs on the upper floors in one building (Tan, 2015; Sabah & Abdul Samad, 2016; Zwain & Bahauddin, 2021). It also called as "rumah kedai" in Malaysian language (Zwain & Bahauddin, 2021) and "*Taimchu*" in Hokkien language which means the house and shop resided within the same building (Nasution & Berbar, 2009). It has dominated many Malaysian old towns before World War II (Chen, 2007; Mamat & Aziz, 2020).

Furthermore, heritage shophouses were built in a group (Elnokaly & Wong, 2015; Tan, 2015) where every unit was physically set side by side, shared the party-walls structure, and attached to each other which form a row of buildings along the street (Chiong, 2014; Tan, 2015). Then, Nasution & Berbar (2009) adds all building units in a row were linked by covered five-footways at the front façade which was required in building development regulations at that time (Awang & Denan, 2017). As one part of the front façade, it functions as a covered area from the weather (Chen, 2007, Zwain & Bahauddin, 2020), transition space between the shophouses, inside and outside of the building spaces, as well as the building and the street (Shamsuddin, 2011). Each unit was built with a narrow width and longer depth building form due to the taxation method imposed by the authorities in their time (Tan, 2015; Nasution & Berbar, 2009). To continue, the internal spaces were divided based on the privacy factor and types of activity conducted by the occupants. Chen (2007) and Tan (2015) explain that normally the business was conducted at the front area on the ground floor level of the house to reach the public. Then, there are more private spaces that are organised at the rear part and on the upper floor of the

house for the family members' use. Thus, these phenomena have formed a compact urban development character in George Town's historic commercial centre where it becomes one of a gauge to calibrate the new building design character compatibility in this paper.
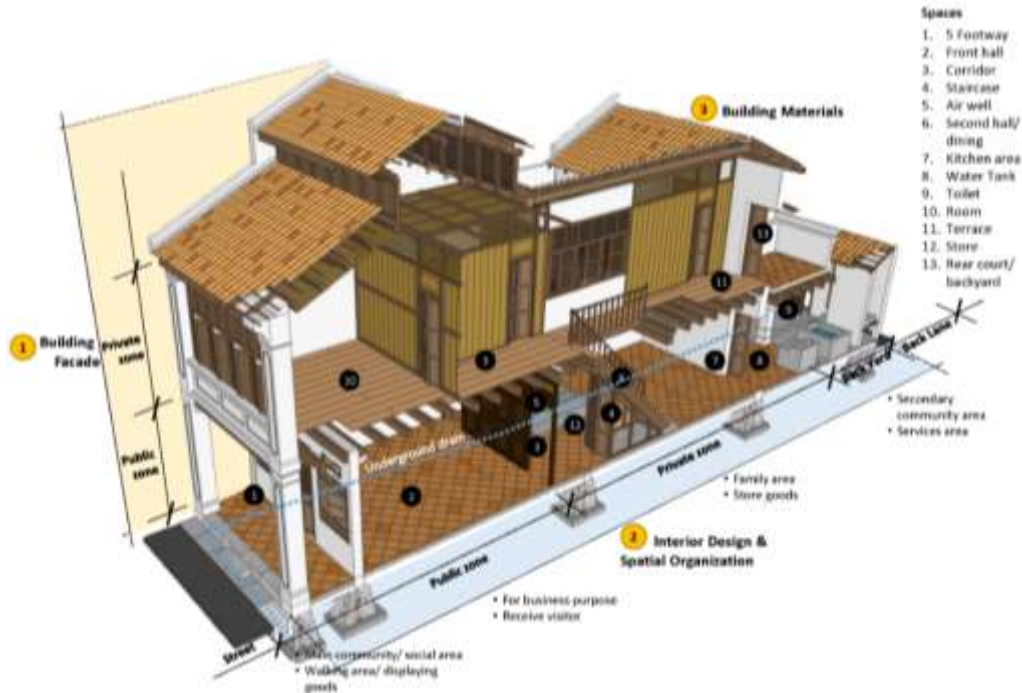


**Figure 2** The typical architectural design of heritage shophouses (Source: Zamri et al, 2023b)

Furthermore, the front façade also was the main building element to express the cultural identity, (Chiong, 2014; Wagner, 2017). It is due to its position that can be perceived from the street view (Penn, 2007; Semes, 2007; Shamsuddin, 2011). Other than the five-foot way, Tan (2015), Ali & Ahmad (2022), and Zamri et al. (2023b) illustrate the front façade of heritage shophouses to cover all elements at the recessed external wall on the ground floor, the upper floors, as well as the roof (Figure 3). It includes the wall, openings' fenestration, the exposed structures, the ornamentation, and decoration, as well as the roof. Normally, the façade width of heritage shophouses is five to seven feet due to the structure capability (Wagner, 2017) and the taxation imposed at that time (Wagner, 2017;

Weebers et al., 2015; Ismail & Shamsuddin, 2005). Therefore, the buildings were expanded longitudinally to the back to add and enlarge the internal spaces (Shamsuddin, 2011; Chen, 2007). Figure 3 shows the transformation of heritage shophouses in Malaysia where it started with the utilitarian design style circa 1600s - 1900s, then enriched by the cultural-based facade elements in 1850s - 1940s and ended with the non-cultural design style in 1930s. Nevertheless, all heritage shophouses' facade transformations did not significantly change the genius loci of the urban historic districts. It is because the building construction and technologies were not aggressively evolved within the timeframe (Chen, 2007; Zamri et al., 2023b).
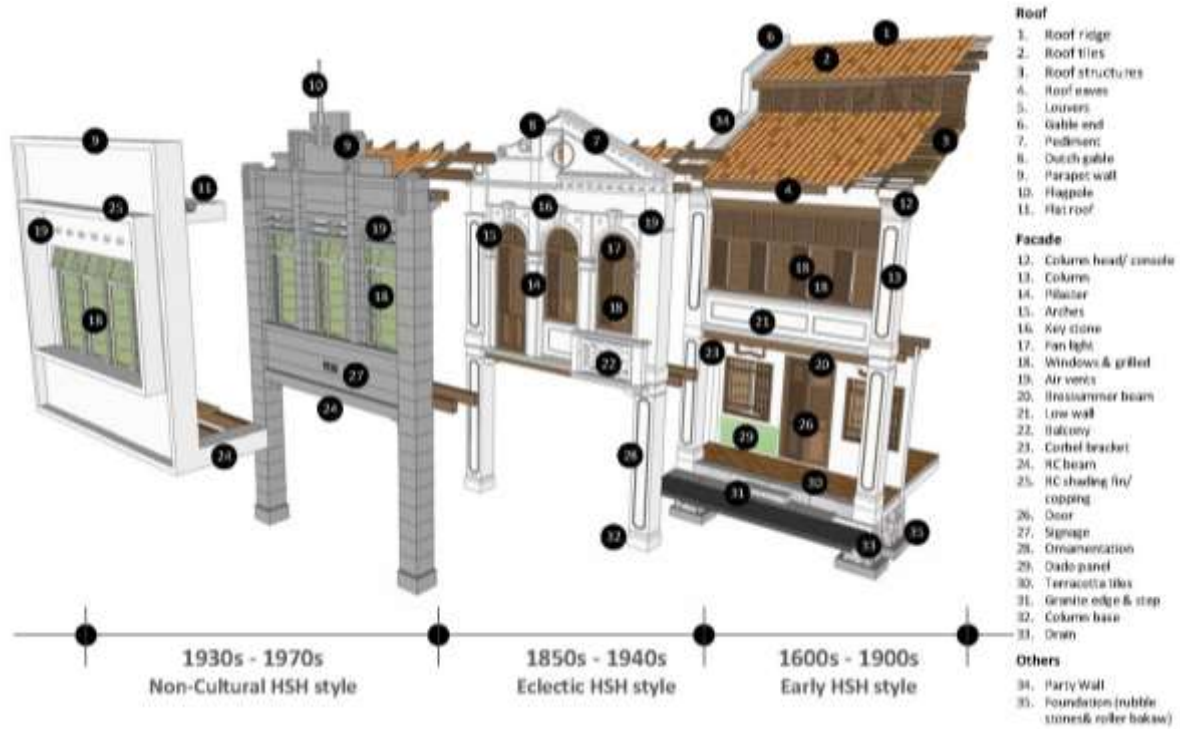
**Figure 3** The front façade typologies of heritage shophouses (Source: Zamri et al., 2023b).

To continue, in the UNESCO World Heritage Site George Town, Tan (2015) suggests there are six architectural style typologies of heritage shophouse that morphologically transformed over time which influenced by the cultural aspirations and technology development. The Early Penang style is the earliest type that built in 1790s-1850s, then it followed by the Southern Chinese eclectic style in 1840s-1910s, Early Straits Eclectic style in 1890s-1920s, Late Straits Eclectic style in 1910s-1930s, Art Deco style in 1930s-early 1960s, and Early Modern style in 1950s-1970s (Figure 4). Nevertheless, when contemporary architecture started to be interpolated into the urban fabric with a significant contrast architectural design, especially in their façade design, it elicited an urgency to evaluate their compatibility with the surrounding context toward the sustainability of the urban historic districts' character.



**Figure 4** George Town heritage shophouse typologies (Source: Majlis Bandaraya Pulau Pinang, 2016)

b) Infill Building Architectural Design as New Architecture Intervention.

Infill building is a new building development or architectural intervention on an infill site within the existing developed area which is normally in an urban area (Alfirevic & Simanovic, 2015). Also, Alhasany (2018) suggests that infill building development is one of the urban

development processes in old towns. It is considered a smart growth strategy in urban areas (Razavian & Samadi, 2016) which either a new building development on a vacant site or a replacement of the existing building due to negligence, abandonment, and decayed structures (Soosani, 2013; Alhasany, 2018). Based on the infill site positions, although the suggestion by Alfirevic & Simanovic (2015) for eight categories of infill building development, Majlis Bandaraya Ipoh (2023) has reclassified it into three categories including the side and intermediate attached unit and free-standing unit of infill buildings which fit the context of Malaysian urban and this paper study. Furthermore, in the UNESCO world heritage site in George Town, concerning the heritage conservation purpose, the buildings are classified into four categories based on their significant value to the urban historic district including the category one, category two, infill building and replacement building (Majlis Bandaraya Pulau Pinang, 2016). The infill building comprises the infill site and the replacement buildings due to their insignificant value to the place. The infill sites can be vacant lots or contain a non-permanent building structure while replacement buildings are the existing modern infill buildings that already built with no heritage value. Thus, in this study, the existing replacement and non-permanent infill buildings are the subjects to be evaluated for their façade design compatibility with the context.

However, besides the consideration of infill buildings as a smart urban development, the incompatibility of infill façade design to the surrounding context in urban historic districts especially to the neighbouring buildings always becomes an issue to the architectural and urban heritage conservation (Brolin, 1980; Semes, 2009; Demiri, 2013; Sotoudeh & Abdullah, 2013). Brolin (1980) summarises that this conflict usually occurs due to differences in architectural design style, scale, materials, façade design articulation and construction between the new and the old buildings.

Furthermore, this is not a new issue in urban areas where it has occurred and is a concern since the 16th century. For notable instances, in the 1521s, Michelangelo's new sacristy was built next to Brunelleschi's old sacristy a century later with different architectural decorative features and Andrea Palladio proposed to wrap the Gothic style Medieval Town Hall of Vicenza with a classical architecture style and white marble arcades in 1545s. However, these lateral buildings' façade design was considered harmoniously compatible with the neighbouring context due to the façade elements and principles reconciliation with the neighbours. Later, after the emergence of modernism architecture, this issue was reheated when modern buildings were erected amid the existing urban fabric with a significant contrast façade design. For example, the museum of Ara Pacis by Richard Meir in Rome's historic district has aroused dissatisfaction among the community for the significant contrast in façade design (Semes, 2009). Thus, a similar phenomenon also has occurred in Malaysian historic districts like the selected case study.

Therefore, many international level heritage conservation guidelines for new building design intervention in historic districts have been enacted to control the phenomenon that occurred including the Burra Charter, Venice Charter, Washington Charter, Vienna Memorandum, and Amsterdam Declaration. These guidelines have underlined the criteria for the new architecture to be built in the existing urban historic districts. Without ignoring the need to fit contemporary needs, the new building design should contextually respect, be sympathetic and harmoniously integrated into the existing historic urban fabric, especially the neighbouring architectural heritages. However, a pseudo-historical in infill building design is not recommended to avoid a falsification of artistic or historical evidence. Moreover, the new building's façade design also must not deteriorate the values of neighbouring architectural heritages, especially the

monumental building type. To continue, the JWN heritage conservation guidelines are also set in line with the international-heritage conservation guidelines for the local context where the design of new buildings must not dominate the place, as well as detract and obscure the cultural heritage significance from its historical character and original interpretation. In addition, the new building design must rigorously consider the architectural heritage and site character. Thus, as the concern of this paper study, it is important to design an infill building façade that is visually appropriate and balances the differentiation and compatibility qualities with the surrounding context in terms of the building mass, scale, and façade articulation to sustain the historical character and value of the place (Bentley et al., 1985; Semes, 2009; Navickienė, 2012; Sotoudeh & Abdullah, 2013).

c) Building Façade Character Evaluation

**Table 1** The previous scholars' façade reading approach.

| Scholars | Façade reading approaches | | | Remarks |
|---|---|---|---|---|
| Bentley et al. (1985) | - Street enclosure ratio<br>- Large scale cues<br>- Small scale cues | | | For general urban context |
| Alfirević & Simonović (2015) | - Building volume, height,<br>- Spatial organization<br>- Building element rhythms | - Artistic details & symbolic emphasizing<br>- Building construction and materials | | |
| Semes (2009) | - Space<br>- Structure<br>- Elements | - Composition<br>- Character | - Proportion<br>- Ornament | For the urban historic context |
| Moughtin (2007) | - Scale & proportion<br>- The symmetricity of façade element<br>- Wall design | | | |
| Soosani (2013), Lambe & Dongre (2016) | - Spatial attributes<br>- Visual attributes | | | |
| Sabah & Abdul Samad (2016) | - Building skylines<br>- Façade rhythms<br>- Façade colour and material | | | For heritage shophouses district context |
| Sabah (2016) | - Additive and subtractive<br>- Axis configuration<br>- Datum<br>- Hierarchy proportion | - Scale<br>- Repetition<br>- Rhythms<br>- Symmetricity | - Unit to whole | |
| Ali & Ahmad (2022) | - Structural<br>- Building enclosure<br>- Opening | - Fenestration<br>- Ornament | | |

Façade is one of the visual elements in building design that characterises the urban historic district (Askari, 2009; Aydin, 2014). It is an external plane that acts as a connector and interface between the internal and external spaces (Askari, 2009; Aydin, 2014; Ching, 2017) to respond to the climatic conditions (Sendi, 2014) and express the identity of the building (Sabah, 2017; Wijaya et al., 2019) as well as community aspirations (Elkadi, 2005; Li, 2007). Thus, the façade design is a spatial and visual composition of walls, openings, fenestration, structures, embellishments (Li, 2007; Ali & Ahmad, 2022), and roof (Baper & Hassan, 2012; Mamat & Aziz, 2020) through the articulation of shapes, scale and proportion, ordering principles, architecture motif, as well as material properties (Bentley et al., 1985, Semes, 2009; Baper & Hassan, 2012; Sabah & Abdul Samad, 2016; Mamat & Aziz, 2020). Table 1 shows the reading approaches to building façade in historic districts done by many scholars. All building elements and façade articulation principles are organised into several visual reading groups to suit their study objectives. Thus, to achieve the research objective, this paper extracts the related façade reading approaches and reorganises them to set the façade design attributes to be evaluated over the existing modern infill building façade design in George Town's historic commercial district (Table 1).

## METHODOLOGIES

The study used a qualitative research method where a field observation study was employed to collect the data on buildings' façade design at the selected site study. The historic commercial precinct of George Town was selected as a case study where it is the heritage shophouse district as well as an early settlement area and the pioneer commercial centre in George Town since the 1780s (Langdon, 2015; Ooi, 2019). Moreover, the site is located within the heritage conservation core zone of UNESCO world heritage site. It is surrounded by four main roads of Light Street, Beach Street, Chulia Street and Masjid Kapitan Keling Street. There are 738 building lots on the site which can be classified into 4 categories. There are 70% of heritage shophouses, 10% of the non-heritage shophouse building or other architectural heritages, 12% of replacement buildings or the existing non-heritage buildings and 8% of infill sites that have been distributed into 19 architectural heritage clusters. The domination of heritage shophouses in this old district has made the place the heritage shophouse district. Furthermore, the percentage of replacement buildings and infill sites in this urban historic district indicates the urban scape changes pressure on this area which shows the urgency to conduct an empirical study to get a precise picture of the phenomenon.
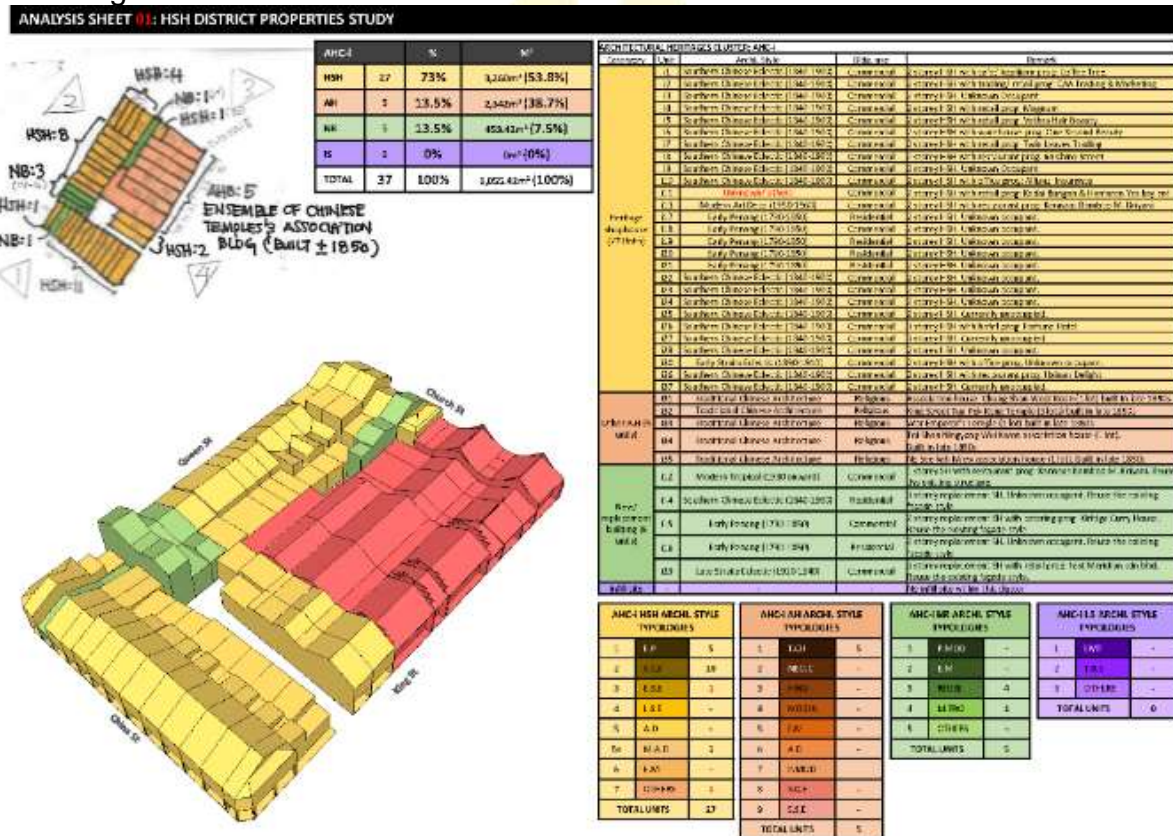


**Figure 5** The data collection sample of each architectural heritage cluster. (Source: Authors)

The buildings' form and façade were recorded through a photographic technique and composed into two types of the recorded data which is the three-dimensional model and the image of building façade according to their building row along the streets and architectural heritage cluster. Besides that, each building's detail background also is recorded and organised into a table form according to their architectural heritages cluster. To continue, the composed façades were then analysed using the building façade visual analysis which is a combination of Bentley et al. (1985), Sabah & Abdul Samad (2016), and Ali & Ahmad (2022) study techniques. It reviewed each building façade component

composition that parsed into the building shape articulation, the scale and proportion, the large-scale cues, and the small-scale cues (Table 2). Furthermore, by representing the modern buildings in the site, the replacement and infill building façade was compared with the neighbouring heritage shophouses in the place.

**Table 2** Building façade visual analysis study subjects

|  | Spatial Attributes | | Visual Attributes | | |
|---|---|---|---|---|---|
| Façade design principles | - Building organization, height, & street enclosure ratio | - Building shape articulation | - Façade's ratio | - Large scale cues (the composition of façade elements) | - Small scale cues (the design and properties of façade elements) |
| Study components involved | - Building setting<br>- Building height & street width | - Wall shape<br>- Roof shape | - Façade width & height | - Opening fenestration<br>- Structures<br>- Ornamentation & decoration<br>- roof | - walls<br>- openings<br>- roof<br>- structures<br>- Ornamentation & decoration |
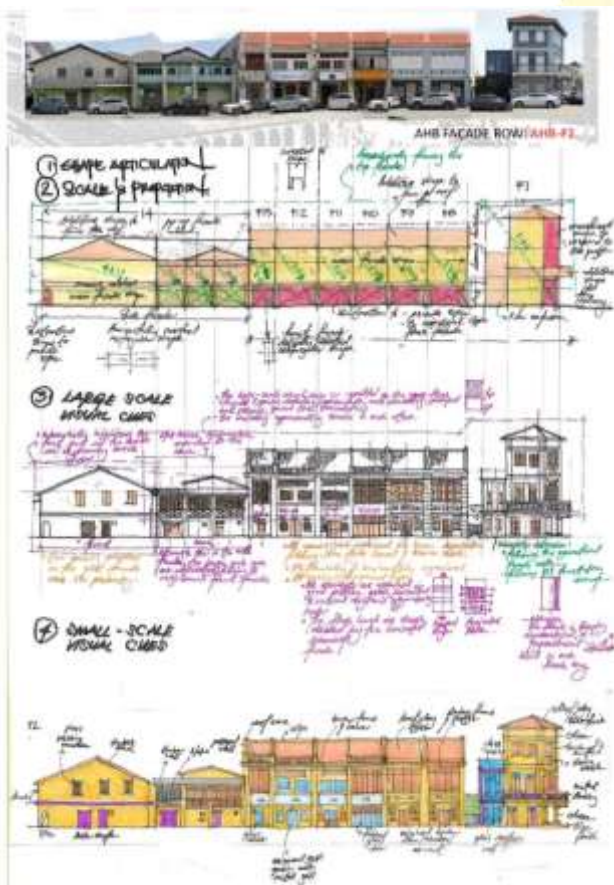


**Figure 6** The façade visual analysis sample (Source: Authors).

## RESULT AND DISCUSSION



**Figure 7** An irregular grid iron pattern and architectural heritage cluster distribution in the historic commercial district, George Town (Source: Authors).

This historic commercial district is organised in an irregular grid iron pattern which resulted in the formation of an internal local road and the 19 unstandardized architectural heritage clusters (AHC). Figure 7 shows the setting of AHCs which are categorised into three categories of plot sizes. The big AHCs are set on the north and east sides of the district which developed by responding to the neighbour's administrative and trading zones on the north. Then, the medium AHCs are set in the middle and the small

AHCs on the southwest side of the district. The reduction of the cluster size is because of the less response to the neighbour's zones on the north and mainly response to local community settlement and the extra grid of Queen Street set in place set in the 1780s. Following that, except for AHC-C, the building numbers, and sizes of each AHC also differ from one to another. The bigger the AHC's size, the larger number and bigger the size of buildings within the cluster. Table 3 shows the building distribution in every AHC. For instance, AHC-D possesses 45 building units and 56% of it is a big building which is the replacement and other architectural heritages. Meanwhile, AHC-L possesses only 24 building units where 79% of it is the heritage shophouses. Moreover, 55% of replacement buildings are built in a big development scale. Thus, through the building development size, it causes a change of place identity in the historic commercial district.

**Table 3** Building distribution in every architectural heritage cluster in George Town historic commercial district (Source: Authors).

| AHC | Heritage shophouse | | Other heritage building | | Existing infill/ replacement building | | Infill site | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Nos | % | Nos | % | Nos | % | Nos | % | |
| AHC-A | 12 | 63 | 2 | 11 | 5 | 26 | 0 | 0 | 19 |
| AHC-B | 28 | 80 | 2 | 6 | 5 | 14 | 0 | 0 | 35 |
| AHC-C | 0 | 0 | 4 | 36 | 7 | 64 | 0 | 0 | 11 |
| AHC-D | 9 | 20 | 17 | 38 | 8 | 18 | 11 | 24 | 45 |
| AHC-E | 21 | 70 | 4 | 13 | 3 | 10 | 2 | 7 | 30 |
| AHC-F | 32 | 97 | 0 | 0 | 1 | 3 | 0 | 0 | 33 |
| AHC-G | 43 | 69 | 13 | 21 | 5 | 8 | 1 | 2 | 62 |
| AHC-H | 32 | 97 | 1 | 3 | 0 | 0 | 0 | 0 | 33 |
| AHC-I | 30 | 81 | 5 | 14 | 1 | 3 | 1 | 3 | 37 |
| AHC-J | 30 | 73 | 4 | 10 | 4 | 10 | 3 | 7 | 41 |
| AHC-K | 33 | 72 | 8 | 17 | 3 | 7 | 2 | 4 | 46 |
| AHC-L | 19 | 79 | 1 | 4 | 4 | 17 | 0 | 0 | 24 |
| AHC-M | 32 | 94 | 1 | 3 | 0 | 0 | 1 | 3 | 34 |
| AHC-N | 35 | 90 | 1 | 3 | 2 | 5 | 1 | 3 | 39 |
| AHC-O | 51 | 91 | 2 | 4 | 3 | 5 | 0 | 0 | 56 |
| AHC-P | 23 | 68 | 2 | 6 | 0 | 0 | 9 | 26 | 34 |
| AHC-Q | 38 | 75 | 1 | 2 | 1 | 2 | 11 | 22 | 51 |
| AHC-R | 21 | 39 | 6 | 11 | 20 | 37 | 7 | 13 | 54 |
| AHC-S | 33 | 61 | 1 | 2 | 12 | 22 | 8 | 15 | 54 |
| **TOTAL** | **522** | **71** | **75** | **10** | **81** | **11** | **57** | **8** | **731** |

a) The spatial attributes of the existing infill buildings' façade

In the spatial attributes study, the research evaluates the building organization, building height, and the street enclosure ratio. Except for the buildings in AHC-C that were built in a loose building organization, the replacement buildings follow the existing building development character where it built side by side, physically attached to each other in their respective row with the unstandardised building lot size. It aligned with Tan (2015) and Zwain & Bahauddin (2018) findings that the building in the heritage shophouses district was built not simultaneously and at different times. Moreover, the replacement building lot size is bigger due to the amalgamation practice of the building lots. For instance, the Sentral College building size is the amalgamation of seven building lots and the Phoenix Press Sdn Bhd building is the amalgamation of four building lots. Next, following the characteristic of the heritage shophouses and other architectural heritages, 93% of replacement buildings were built directly facing the street and connected to it. Thus, it means that for the building organization aspect, the replacement buildings' façade design significantly follows the compact spatial

organization character of this historic commercial district.

Next, it is found that this historic commercial district is a low-rise development due to the domination of the heritage shophouses since the 1786s (Ooi, 2019; Tan, 2015). 87% of heritage shophouses were built two storeys high and only 13% that built three storeys high. However, 61% of replacement buildings were built more than two storeys and significantly dominated the skyline. There are 25% of them are three storeys, 9% four storeys, and 27% five storeys and above. Even worse, the highest replacement building in the site is 14 storeys high. In addition, in the aspect of street enclosure ratio, 35% of the replacement buildings distributed within 13 AHCs have inverted the original street enclosure ratio from the range of 1:1 to 3:1 ratio into 1:3 to 3.5:1 ratio. Most of the higher buildings are in the AHCs that close to the neighbour's administrative and trading zones. Thus, it has broken the low-rise skyline pattern and resulted in dwarfing of the existing architectural heritages in the district. It proven the finding of Shamsuddin (2011) that the new modern building development is insensitive to the historic context.

b) The visual attributes of the existing infill buildings' façade

In the visual attributes study, the research evaluates the building shape articulation, façade ratio, large-scale cues, and small-scale cues. Under building shape articulation, there are 2 sub-attributes of the whole façade and the sub-unit façade shape. 73% of replacement buildings' whole facade follows the vertically oriented rectangular façade shape attribute for front façade design but the rest 23% did not follow through either the diamond like or horizontally oriented rectangular shapes. It is due to the retainment of the façade ratio aspect in their façade design and full utilizing the building lot area. However, in terms of the sub-unit façade shape articulation, the replacement buildings' façade design against the district character where 55% of

it don't follow the symmetrical inverted U shape building façade in the district. Those façades were designed with the asymmetrical additive and subtractive shapes in their façade shape articulation. The one that conformed the sub-unit façade shape articulation of the district was those that reused the structure of the previous building. It is due to the application of the advanced building construction technology in their building façade design (Sabah & Abdul Samad, 2016; Ching 2017), different architectural design approaches (Semes, 2009) and introduction of new building program (Chen, 2007). Thus, although the whole façade shape looks compatible with the neighbouring heritage buildings' façade, the sub-unit façade shape articulation ruined the compatibility quality. In addition, the ruination is multiplied with the gigantic building scale of the replacement buildings.

Generally, in this historic commercial district, the heritage shophouses' façade ratio is approximately 1:2 ratio for the front façade. Continuing from the practice of building lot amalgamation to enlarge the building scale, 30% of replacement buildings were built against the district's front façade ratio without having façade ratio reconciliation to maintain the historic horizontal rhythms along the streetscape. Although the percentage of units involved is considered small, the impact of the discontinuity of façade rhythm along the street is significant. It is due to the interrelation factors with other attributes of building shape and height that are also against the district's spatial attributes. To continue, at the corner unit of heritage shophouses, the façade ratio on the side façade was overturned the front façade ratio. The side façades were set to be a maximum 4.8:1 ratio depending on the space availability at the back. It aligns with Tan (2015) and Chen (2007) finding that the heritage shophouses' spatial organization is set in longitudinally to the back. Moreover, the heritage shophouses' side façade found has evolved from a simple façade design to the stage that has façade reconciliation via the façade bay

organization to continue the rhythm character of the front façade. It agrees with Shamsuddin's (2011) finding that the architectural heritage design approach always tries to respond to their neighbouring context. However, the application of this design approach is discontinued in the replacement building facades design. Only 22% of replacement building corner units applied façade reconciliation to harmonise with the neighbours. Therefore, these phenomena have discontinued the historic value of the district.

Next, in the large-scale cues study, it evaluates the vertical and horizontal rhythms from whole to units as well as among the buildings in a row and the façade's elements configuration including the openings fenestration, structures and decorations composition. Basically, in this historic commercial district, the large-scale cues of heritage shophouses' front façade are globally symmetrical order but in the corner units, it has been altered to a global asymmetrical order but balanced back with a locally symmetrical order in the façade bays. The articulation of the large-scale cues always concentrates on the upper floor façade and is rhythmically organised in a regular grid organization that is governed by a central axis that act as a datum. Moreover, the number of openings on the upper floor is unstandardised which was set according to the architectural style and the width of the façade. However, its fenestration is always organised linearly, emphasising the horizontal rhythm, and symmetrically following the façade grid. On the ground floor, there are 2 types of fenestrations which include the tripartite and full-length organization depending on the building's function. Nevertheless, it is less emphasised and not significant to the large-scale cues' aspect. On the side façade, the facade richness is reduced. However, in the post-1890 heritage shophouse units, there is a façade reconciliation applied which expands the front façade articulation principles. However, it is found that 52% of replacement buildings were designed with different large-scale cues. Continuing from the incompatibility quality in other aspects, these replacement buildings' cues were organised in a globally asymmetrical order, with different hierarchy composition principles, clustered façade elements organization or in irregular grid composition and has no façade reconciliation for the wide facade. For instance, the modern bank and insurance buildings along Beach Street were designed in a globally asymmetrical façade order, have no compositional hierarchy, clustered composition via irregular grid pattern and have no façade ratio reconciliation for the wide facade. On top of that, these buildings discontinue the horizontal rhythm of the existing heritage shophouses in their respective row which have broken and changed the pattern of the streetscape. Thus, this phenomenon has multiplied the incompatibility of the replacement building façade design to the district's historic character where it deteriorated the place's historic values.

To continue, the small-scale cues are the façade elements properties including the material use, façade elements' detail articulation, and colours. All architectural heritages in the district especially the heritage shophouses are mainly characterised by a plastered clay brick material. The walls and structures were plastered either with a lime mortar or cement mortar (Tan, 2015). It is due to the building development requirement imposed by the authority for firefighting purpose after the big fire tragedy of heritage shophouses in the 19th century in Penang (Zwain & Bahauddin, 2017) and other Malayan old towns (Wagner, 2017; Chun et al., 2005; Savage, 2001). However, the application of roof clay tile is significantly low where it was replaced by asbestos and metal deck material started from 1970s (Tan et al., 2016). Thus, it means that the mate surface material is one of the main elements that contribute to the identity construct in the district. Continuing from that, 73% of replacement buildings have conformed to this design character. Nevertheless, the rest 27% that defied this design character cannot be

taken lightly especially when their building scale is significantly bigger than the neighbouring architectural heritages and the percentage of glazing material is vast in their façade design. It is because of the damaging impact towards the place's character and the historic values of the vicinity context that still seen considered significant. Furthermore, aligns with Tan (2015), the colour concept of all heritage buildings in the district is in the low-chromatic colour scheme and uses traditional colour palettes which are the white and yellow ochre. It means that the traditional colour concept is continuously maintained being applied in the replacement buildings' façade to sustain its historic vibrancy. Similarly, 90% of replacement buildings have applied the same colour concept. The balance is 10% against the colour concept through the dark tinted glazing, peach, and maroon colours which bold to the place.

Lastly, to complement the heritage shophouse façade design, the traditional ornamentation was highly applied including the ornamented air-vents,

fanlight, transoms, and lattice works as well as the moulded walls, structures, and stuccoworks with many cultural base motifs. The intensity of the ornamentation application is depending on the architectural styles imposed in the façade design. Thus, it shows that intricate ornamentation with a similar is a must in designing building façade in this historical commercial district to maintain its character and historic values. However, 50% of replacement buildings are found against this characteristic concept through their simple plain walls and boxes shape design. Thus, it has deteriorated the streetscape character of this historic commercial district. For instance, the Sentral College and three bank buildings at Bishop Street abruptly disconnected the ornamentation elements and changed the streetscape character. Therefore, in the small-scale cues, the majority of replacement buildings are only conforming to the building material finishes and the colour concept but against the ornamentation character of the district.

**Table 4** The summary of the compatibility fitness study on the existing replacement and infill buildings' façade.

| Building Attributes | | Sub-attributes | Replacement Buildings | Remarks |
|---|---|---|---|---|
| Spatial Attributes | Building organization | Façade Orientation | / | • Except AHC-C's buildings, all other buildings follow the compact spatial organization character of the district.<br>• The different lot size attributes are due to the amalgamation practice. |
| | | Wall sitting | / | |
| | | Wall Alignment | / | |
| | | Lot size | X | |
| | Building storey height | - | X | • Disrupting and dominating the skyline of the districts. |
| | Street enclosure ratio | Street width vs building façade height | X | • Inverted the street enclosure ratio from 3:1 to 1:3. |
| Visual Attributes | Building shape | Whole shape | / | • Full utilization of building lot. |
| | | Sub-unit shape | X | • Asymmetrical additive and subtractive shapes. |
| | Building façade ratio | Front façade | X | • The ratio against the character without façade ratio reconciliation. |
| | | Side façade | X | • Discontinue the façade ratio reconciliation design trend |
| | Large-scale cues | Symmetricity | X | • Globally asymmetrical order |
| | | Façade rhythms | X | • Clustered organization. |
| | | Fenestration | X | • No façade composition reconciliation. |
| | Small-scale cues | Material use | X | • The building size emphasises the impact of material distinctiveness. |
| | | Colour | / | • Follow the traditional colours. |
| | | Detailing | X | • Deteriorating the street scape through their simple plain and boxes shape design. |
| | | **Result** | | Incompatible façade design to the surrounding context character |

## CONCLUSION

As the early settlement and the pioneer commercial centre, George Town's historic commercial precinct is the heritage shophouse district that possesses a strong urban identity. Furthermore, heritage shophouse is the main heritage building type that has significantly contributed to urban identity construct through its spatial and visual attributes. However, in the post-independence of Malaysia, the historical character of this urban historic district was threatened by infill building development. The contrary façade design of infill buildings to the surrounding urban context has elicited anxiety upon the historic districts' character and its value deterioration over the different architectural design convergence. The analysis of the existing infill buildings' façade has revealed the incompatibility fitness in the façade design of the existing infill buildings or the replacement buildings. It is due to the replacement buildings' façade design disconformity upon the heritage shophouses' design façade design character in the historic commercial precinct. The replacement buildings' façade mainly against the historic district's building storey height, street enclosure ratio, building shape, building façade ratio, large-scale cues, and small-scale cues. Thus, although continuous urban development is pivotal, it also negatively affects the urban historic district identity which significantly urged to be taken into consideration seriously for its cultural heritage conservation.

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# BUILDING INFORMATION MODELLING BASED DIGITAL TWINS FOR GREEN RETROFIT OF EXISTING BUILDINGS: Trends, Challenges and Opportunities for Malaysia.

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## ABSTRACT

Due to the need for sustainable development, the AEC industry must constantly discover novel ways to maintain or retrofit existing buildings. While Building Information Modeling (BIM) has proven to be a valuable tool for designing and managing new construction projects, its potential in retrofitting existing buildings has not been fully realised. A few studies have explored and developed frameworks for BIM for retrofitting and greening existing buildings; however, the study aims to explore the themes of BIM-based Digital twins, Internet of Things (IoT) for real-time monitoring, data analytics and Machine Learning to enable decision making for green retrofit of existing buildings.

This paper provides a concise overview of the underlying concepts and briefly examines existing literature. It employs scientometric analysis and VOSviewer to depict the most influential publications in the field visually. Extensive searches were conducted on the primary database to gather relevant information.

This study presents a network visualisation depicting keywords, countries with the highest citation counts, and co-authorship in the field of research and the findings of this analysis shed light on the implications and potential opportunities for future research, with a particular focus on Malaysia.

*Keywords: Digital Twins (DT), Internet of Things (IoT), Building Information Modeling (BIM), Green Retrofit Design, and Scientometric Analysis.*

## 1. INTRODUCTION

The existing building stock in Malaysia consists of an abysmal number of green-certified buildings. Although there are various rating systems utilised, such as the Green Real Estate (GreenRE) and Leadership in Energy and Environmental Design (LEED), spearheaded by the US Green Building Council (USGBC), the Green Building Index (GBI) is the widely accepted tool in Malaysia. It is estimated that there are approximately 400 GBI-certified green buildings (Suhaidi, 2023). Compared to the total number, which consists of 6,022,030 residential units,

545,639 shops, 304,882 serviced apartments, 52,660 Soho buildings and 119,551 Industrial buildings (Napic, 2022). Ha et al. 2023, identified economic, technological, financial, knowledge, political and other barriers to implementing green building. On the economic side, factors such as the high initial cost of construction, and low market demand, are significant disadvantages that need to be explored. Lack of expertise, technological know-how and a database of information on green buildings were cited as challenges in the technical aspect. A lack of incentives, financial support, policies, building codes and regulations were cited as sub-barriers on the financial and political sides.

Green retrofitting proffers solutions to achieve the targets for reducing energy use and global carbon emissions. Although Lim et al. 2021, identified that although various energy simulation tools have been developed, the decision process for retrofitting usually conflicts with other goals. Building Information Modelling (BIM) was identified as a collaborative tool that enables members within the AEC industry to communicate and share information within a centralised digital model. The study's findings revealed that research in this area is still in its infancy and unverified. Of the limited publications incorporating BIM for purposes ranging from building operation and maintenance to refurbishment phases, only 34 publications addressed green retrofitting and 9 sustainability assessments.

Globally, there is increased interest in commercial and academic circles for Digital Twins. Zhou et al. (2022), to clarify the definition, describe digital twins as an advanced modelling and simulation environment of either a system, service or product that combines the latest Information Communication Technology (ICT) to manage, measure and predict in real-time its conditions and performance. Similarly in a review by Shahzad et al. (2022), the most relevant description of DT described it as a living model of physical assets which adapt continuously to operational changes based on data collected online, with the ability to forecast future performance (Qi &Tao 2018). The origins of Digital Twins can be traced back to the aerospace and automotive industries with the AEC industry regarded as late adopters (Nour El-Din et al., 2022). The key enabling technologies are Computer-Aided Manufacturing CAM, Computer-Aided Engineering CAE and Computer-Aided Design CAD. In the fourth industrial revolution with its technologies such as the Internet of Things (IoT), BIM has been identified as being a platform that can enable the creation of digital twins which could be beneficial for decision support for green retrofitting.

This review aims to investigate the recent developments in IoT and BIM-based DT to support retrofit decisions. The underlying objectives are to:

1. Investigate the current approaches, benefits, and trends in IoT and BIM-based DT for green retrofitting
2. Elucidate the research gaps.

The subsequent sections of this review provide insights from extant literature into the practical and theoretical developments of IoT and BIM-based DT in the AEC industry and implications for green retrofitting. Section 3 of the paper outlines the methodology employed for this review. In Section 4, the scientometric review's results are presented, covering various subjects such as keywords, analysis of countries involved in DT research, co-citation and co-authorship networks. Section 5 of the paper discusses the

research opportunities and challenges. Finally, in Section 6, the conclusions drawn from the results are presented, along with recommendations for future research.

## 2. LITERATURE REVIEW

Bu et al., (2015) provide a classification of Green Building Design, the categories defined were New Design (ND) and Retrofit Design (RD) or Green Retrofit Design (GRD). They describe it as an incremental improvement to a building's envelope and systems with the sole purpose of improving its performance. In other words, it is a financially advantageous enhancement of a currently occupied building to minimize energy use, water consumption and improve occupant satisfaction/ comfort. The process of retrofitting existing buildings is crucial as they contribute to most energy inefficiencies. Some barriers highlighted include the communication gap between building occupants and Architects or Engineers and the up-front costs of refurbishment.

Building Information Modelling is a platform with the potential to aid in retrofit decisions, however, its capabilities have not been maximised in the construction and operations phase. Research suggests that existing document-based asset management practices can be transformed into model-based ones (Shahzad et al., 2022). Lim et al., (2021) categorise BIM as follows: Authoring, Analysis and Collaboration. BIM Authoring tools include software such as REVIT, ArchiCAD, All Plan, GT Digital Project, Rhino Inside Revit etc. BIM Analysis tools include Autodesk Ecotect Analysis(discontinued), Autodesk Green Building Studio, Graphisoft EcoDesigner, IES Solutions Virtual Environment VE-Pro, Bentley Tas Simulator, Bentley

Hevacomp, DesignBuilder (Ige,2023). Most BIM collaborations are usually cloud-based and founded on open standards as highlighted by Succar (2009), in his delineation of BIM as Object-based modelling, model-based collaboration and network-based integration. Examples include Autodesk BIM Collaborate Pro (formerly BIM 360), Bentley ProjectWise, and Trimble Connect amongst others.

To harness its full potential in making retrofit decisions, the extent of application or lack of BIM in Facility Management needs to be examined. Ensafi et al.(2021), categorise the barriers and challenges to implementing BIM for FM as technology and process-based and organisational. On the organisational level, the inability to articulate BIM requirements by facility owners and the cost associated with training and implementation are notable challenges. An overabundance of data, difficulty with updating models with as-built information and interoperability issues are some of the identified issues associated with tech and process-based barriers. Similarly, Ruohomaki et al. (2018), noted that global implementation of digital twins was not observed due to a lack of technological support.

### 2.1 BIM-based Retrofit

BIM is currently deployed for use in New Design (ND). Literature and practical use cases on the use of BIM for retrofit purposes are limited as highlighted by Edwards et al., (2019). This is mainly attributed to challenges such as data acquisition and management, interoperability between BIM and simulation software, as most research work applies BIM to retrofit buildings for visual, thermal or and acoustic comfort. Furthermore, unlike new construction, green retrofit decisions are usually constrained by the structure of the existing

building (Lim et al.,2021). The acquisition of data for retrofit projects in cases where a BIM model is non-existent usually involves the use of construction drawings. Where historic data has been lost 3d photogrammetry/ laser scanning is employed and the point-to-cloud process may result in errors thus necessitating manual modelling and corrections, especially of interior spaces. Further Research is essential to improve and automate the process of transferring Point Cloud data captured into the BIM model with minimal errors (Kim et al., 2018).

Another barrier is the lack of definition of the Levels of Development for Green Retrofit projects, attributable to required parameters such as indoor comfort, sustainability assessment, operational energy, solar, cost and lifecycle analysis. Further investigation into methods and procedures for optimizing building performance and providing visualizations and feedback to aid in design decision-making is crucial. This creates an opportunity for the utilisation of Industry 4.0 technology in data collection (Scherer and Katranuschkov, 2018).

### 2.2 The Role of ICT in AEC

Modern-day Information and Communication Technologies (ICTs), commonly referred to as Industry 4.0 comprise a range of advanced tools and systems such as industrial IoT, real-time synchronization, discrete event simulation, visualization, big data analytics, industrial artificial intelligence, industrial blockchains, cloud computing, and similar innovation.

Wang et al., (2020) identified and analysed at least fifteen (15) typical digital technologies adopted by off-site construction (OSC) projects, including building information modelling (BIM), the Internet of Things (IoT), global positioning systems (GPS), radio frequency identification devices (RFID), geographic information systems (GIS), sensors, augmented reality (AR), virtual reality (VR), photogrammetry, laser scanning, artificial intelligence (AI), 3D printing, robotics, big data, and blockchain. Similarly, Darko et al., (2020) discovered through scientific mapping that, genetic algorithms, fuzzy logic, neural networks, fuzzy sets, and machine learning are the most widely used AI tools for simulation, optimisation, project management etc. Another review examined applications of machine learning techniques for BIM-generated data while another reviewed its application to green buildings where an argument was made for a coined terminology referred to as AIoT or AI of Things. It was described as a new generation of the Internet of Things (IoT), which integrates AI methods with IoT infrastructure for more efficient IoT operation and data analysis. Hence, the Internet of Things (IoT) refers to a network of interconnected physical devices, including sensors, mobile devices, and wireless technologies like RFID, wearables,3D laser scanners, actuators, and drones. These devices are connected to a construction resource, such as a building, to collect real-time data about the project's operational status. (Debrah et al., 2022, Zabin et al., 2022 & Saka et al., 2023).

### 2.3 The Potential Benefits of Digital Twins for Retrofit

For researchers in the AEC field, DT is reliant on modelling, engineering and simulation and cloud computing. For researchers in ICT, DT is reliant on IoT, blockchain, artificial Intelligence real-time data sensing etc. Arguably, an interdisciplinary approach is needed to

create a symbiotic BIM-based DT for retrofit decisions which have the potential to precisely assess the energy consumption of a building, its compliance or lack of in terms of green building rating systems (Zhou et al.,2022).

Certain studies, for instance, have employed a Machine Learning Model for a range of retrofit influencing tasks such as fault detection and diagnosis of chillers to predict how efficient the natural ventilation systems of Green Buildings are. Finally, integrating AIoT in web-based systems collects sizable data to enhance BIM for making informed decisions regarding green retrofitting. BIM, acting as a digital representation, serves as the initial stage for creating a digital twin. (Park &Park 2021, Debrah et al., 2022). Participants in a study by Shahzad et al., 2022, argue that BIM alone lacks the capability for decision support while Digital Twins are ideal for use post-construction as that is when there is a physical object from which a DT can be created.

### 2.4 Levels Of Digital Twins in the AEC Industry

It can be argued that DTs are categorised based on the field in which they are utilized. Agrawal et al. (2023), when delineating the roles between humans and DT, categorised Digital twins based on the roles they play as follows: Observer, Analyst, Decision maker and Action Executor. Madni et al. (2019) also provide a categorisation based on the automation levels as: "Pre-Digital Twin, Digital Twin, Adaptive Digital Twin and Intelligent Twin. Another categorisation based on the degree of data integration provides 3 categories as follows: The Digital Model, The Digital Shadow and the Digital Twin. The first is just a virtual model of the physical object while the second has a one-directional data flow from the physical

object to the digital model. Under this categorisation, a digital model only qualifies as a DT if the is a bi-directional data flow (Kritzinger et al., 2018).

There are five levels of DT considered relevant for the AEC industry as defined by Verdantix, a research and advisory firm. They are Level 1: The Descriptive Twin, which is the most basic level of the digital twin, provides a visual duplicate of a physical object or system, alongside live, editable design and construction data, including 3D models and BIM. Level 2: The Informative Twin, adds increased integration with sensors and operations data for insights at any given time. Level 3: The Predictive Twin, takes this a step further, capturing real-time data, contextual data, and analytics to identify potential issues. Level 4: The Comprehensive Twin, leverages advanced modelling and simulation for potential future scenarios as well as prescriptive analytics and recommendations. Level 5: The Autonomous Twin, can learn and make decisions through artificial intelligence while using advanced algorithms for simulation and 3D visualization. (Autodesk, 2021 & 2023)

### 2.5 Adoption of Digital Twins in Malaysia

The Pan Borneo Highway is a pioneering case study for the implementation of a BIM-based Digital twin in Malaysia. This was achieved using a combination of BIM, Geographical Information System (GIS), and Reality Modelling. The BIM platform used is the Bentley ProjectWise and AssetWise. Reveron a Bentley Channel Partner was selected by Lebuhraya Borneo Utara (LBU). Early clash detection and managing design and construction data were facilitated by ProjectWise using the connected data environment.

(Bentley, 2020 & Shaharuddin et al., 2022). Akob et al. (2019), report that the level of Development (LOD) for the first phase of the development was BIM Level 2 and provided up to a LOD of 500. Divided into 11 work packages for every 60-90 km, the BIM team for each package comprised "55 BIM Modellers, 11 BIM Coordinators, 8 BIM Specialists, 4 BIM Lead Family, 1 BIM Lead Coordinator and 1 BIM Director". The tools utilised for modelling include Autodesk Revit, Autodesk Civil 3D, and Autodesk Infraworks. For coordination and management, Autodesk Navisworks, Bentley ProjectWise, and Oracle Primavera P6 were utilised.

## 3. METHODOLOGY

Presented in this review is a scientometric and bibliometric analysis of publications regarding IoT-based DT in the AEC industry. The papers and articles chosen for analysis in the scientometric review will be selected using metrics such as countries and institutions leading in the research, most cited authors, top keywords etc. This will aid in achieving the aim and primary of this study. The Bibliometric review involves compiling and analysing scholarly work on IoT-based DT. The scientometric phase involves mapping scientific domains, comprehending the citations, measuring the influence of scientific research, analysing sets of articles to evaluate the influence of institutions and journals, and developing indicators to assist in policy and management applications (Zhao, 2017 & Tanko and Mbugua, 2021).

The first process in the bibliometric analysis is identifying the key database, keywords, and criteria to screen documents resulting from the search. For this study, information will be retrieved from Scopus and subsequently analysed in VOSviewer, a map-generating computer program that utilises network data and allows users to visualise and investigate the maps. The terminology from the maps includes items, link(s), Network, cluster, weight attributes, score attributes etc. VanEck & Waltman (2023), describe Items as the subjects of focus in a particular study such as keywords, researchers, or publications. Links are connections between 2 or more items. A network is described as a set of items together with their links while a cluster is a group of items. Weight and score attributes are numerical values that indicate an item's importance and property respectively.

The initial search filter was Article title, Abstract and Keywords. To minimise bias, literature was collected from a range of sources to cover interdisciplinary themes. However, the scope was limited to articles, conference papers and reviews, excluding policy papers, books, theses, and reports.

Research query was carried out on 20 July 2023 with the following final string: TITLE-ABS-KEY (Bim digital AND twins ) AND ( LIMIT-TO ( DOCTYPE , "ar" ) OR LIMIT-TO ( DOCTYPE , "cp" ) OR LIMIT-TO ( DOCTYPE , "re" ) )

Summarily the search methodology is divided into 3 phases as shown in Fig 1 below.

# 4. SCIENTOMETRIC ANALYSIS

A Scopus search with the keywords "BIM" and "Digital Twins" was the initial stage to obtain Bibliographic data. The search resulted in a total of 573 documents with records spanning from 2017-2023 as the first DT article was published in 2017 and the subject has become prominent in academia since then (Jones et al, 2020).

## 4.1 Keywords

Keywords have a fundamental role in scientometric science, as they provide an overview of the current research trends in a particular subject area and serve as a source for determining gaps in that field. Figure 2 shows the mapping of keywords with the VOSviewer program. The circle sizes represent the degree of keyword co-
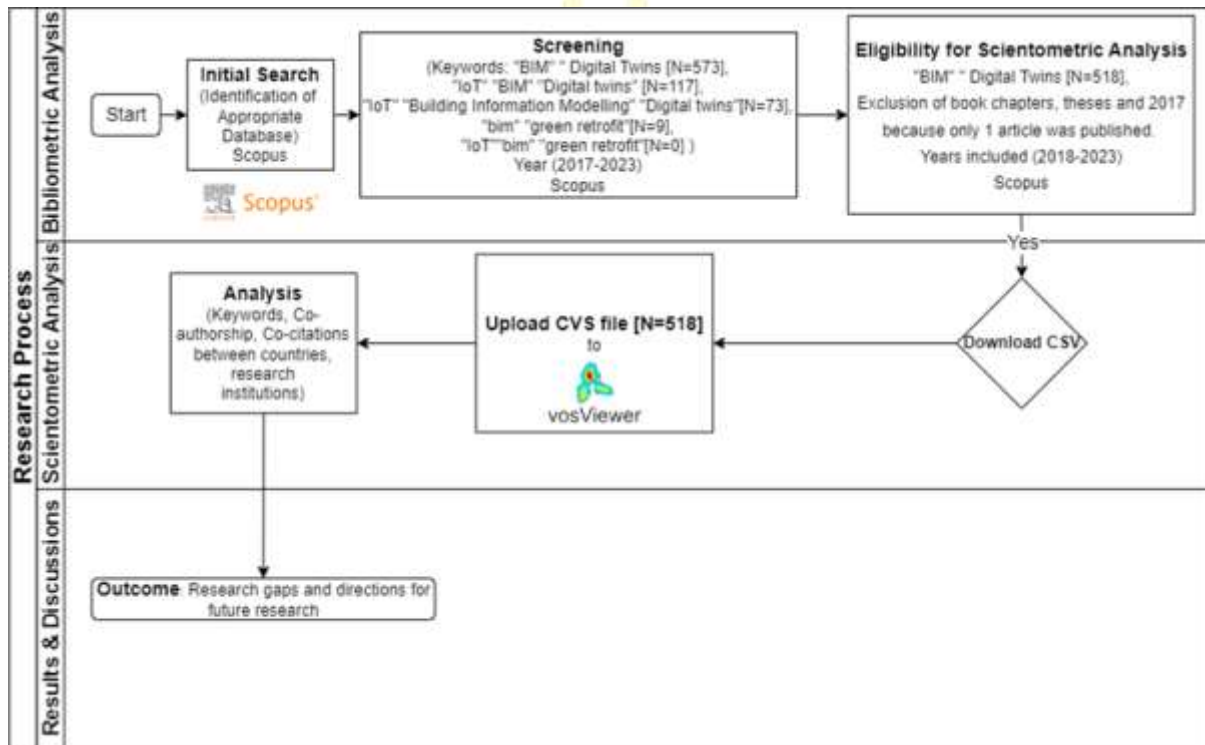


**Figure 1 .** Swin lane diagram of the Filtration and review strategy Courtesy draw.io .

There has been a substantial surge in the number of related publications, processes, concepts, and envisioned applications in the AEC industry from the time of the first article (Nour El-Din et al, 2022). The search was narrowed to sustainability assessment with the keywords "IoT", "BIM" and "Digital Twins resulting in 117 documents. Substituting the acronym BIM with "Building Information Modelling" in the previous search criteria resulted in 73 documents. While a search for "BIM" and "Green retrofitting" revealed a limited number of articles, 9 in total. At the time of this study a search using the terms "IoT""bim" and "green retrofit" returned without results.

occurrence, where the larger circles indicate the most frequent research topics. The line thicknesses between the keywords indicate the closeness of their link. Closer points represent a stronger connection between the keywords (Van Eck and Waltman, 2017). The analysis identified several keywords, their frequency, and link strength. Based on the keyword analysis, the emerging research areas are on the peripheral parts of the map or represented as small bubbles. To buttress the need for research into IoT and BIM-based DT for green retrofit, the analysis had a total of 25 clusters comprising 1000 items but revealed only 1 item relating to retrofitting (3 occurrences,

**Fig. 2.** Visualisation of Keywords and Frequency Courtesy VosViewer



**Fig. 3.** Number of Publications by Top Countries and Malaysia Courtesy Scopus.

43 total link strength). The other areas occurring sparingly include areas such as decision support systems (6 occurrences, 103 total link strength), IoT(27 occurrences, 294 total link strength) Fault detection (4 occurrences, 47 total link strength), Real-Time Monitoring (3 occurrences, 32 total link strength), damage detection (4 occurrences, 51 total link strength) as shown in Figure 2.

## 4.2 Analysis of Countries Involved in Research

Globally, Italy (70) leads in significant contributions to the research into the subject, query results from the Scopus database reveal that China comes second with (85) publications, followed by the United Kingdom (78), and Germany (61). European countries are pioneering research in this field as the European Green Deal initiative anticipates that Digital Technology (DT) will play a significant role in promoting a sustainable transition through technological advancements. Other notable countries include the United States (48), Australia (36), and Canada (23), while the research in Malaysia has produced only (6) publications and is still in its infancy. It is however noteworthy that although Malaysia leads in terms of research on BIM for green retrofitting, it is ranked 28th in research efforts into BIM-based DT while neighbouring Singapore ranks 13th in terms of document count by territory or country on the Scopus database.

## 4.3 Co-Citation between Countries

The co-citation between publications from various countries was also examined in the bibliometric analysis, as shown in Figure 4. In this study, the basis of ranking is the total link strength. The analysis revealed that the United Kingdom has the most total link strength, and citations, in

cluster 5 with 17 links and a total link strength of 41 and 1815 citations, China is second in cluster 4 with a total link strength of 31, 10 links and 881 citations. the United States is third in cluster 2 with 15 links, total link strength of 26 and 674 citations while Malaysia is on the periphery with a total link strength of 2,1 link to the United Kingdom, and 22 citations. These findings indicate an opportunity for growth in this area of research for Malaysia, especially in terms of co-authorship with Singapore which has a total link strength of 8, and 600 citations.

## 4.4 Co-Authorship Network and Affiliations

Research revealed in the first quarter of 2023, as shown in Fig.5 that the leading author in terms of total link strength is Parlikad A. K affiliated with the University of Cambridge, UK with 4 links, 8 documents and a total link strength of 14. Although Brilakisi I. also affiliated with the University of Cambridge, UK is the most cited researcher with 238 citations, the total link strength is 5. The threshold set there was a minimum of three (3) documents per author. When the thresholds were reduced Rezgui Y. of the University of Cardiff, UK is the most cited author although his publications are 4 in number relating to this field of research. Kaewunruen, S. of the University of Birmingham UK, comes in second while Lu Q. of the Bartlett, UCL, UK is ranked third.

The authors from Malaysia however did not meet the threshold as they have one publication each. They are however, affiliated with the following institutions: University of Malaya, Universiti Teknologi Malaysia, Universiti Kebangsaan and Universiti Teknologi PETRONAS while the top affiliations are the University of Cambridge, Politecnico di Milano, Sapienza Università di Roma, University

College London, UNSW Sydney, Ministry of Education China, National University of Singapore, University of Birmingham, Huazhong University of Science and Technology and The Bartlett Faculty of the Built Environment, UCL, UK.

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Huazhong University of Science and Technology and The Bartlett Faculty of the Built Environment, UCL, UK. However, at the time of this writing, the selected threshold in VOSviewer to effectively rank authors in this field of research was set to a minimum of one (1) document per author with no required minimum for the number of citations. All 499 authors, met the threshold. The results of the network visualisation show a weak link between authors with 497 clusters and 2 links as shown in Fig 6. The two links are highlighted in red and green. For co-authorship between countries, 29 out of 64 countries met a threshold of a minimum of 5 documents. Also, Kaewunruen, S has become the top author in terms of document count as analysed by Scopus in Fig 7. The most cited Authors however are, Pan Y & Zhang L. with 450 citations.
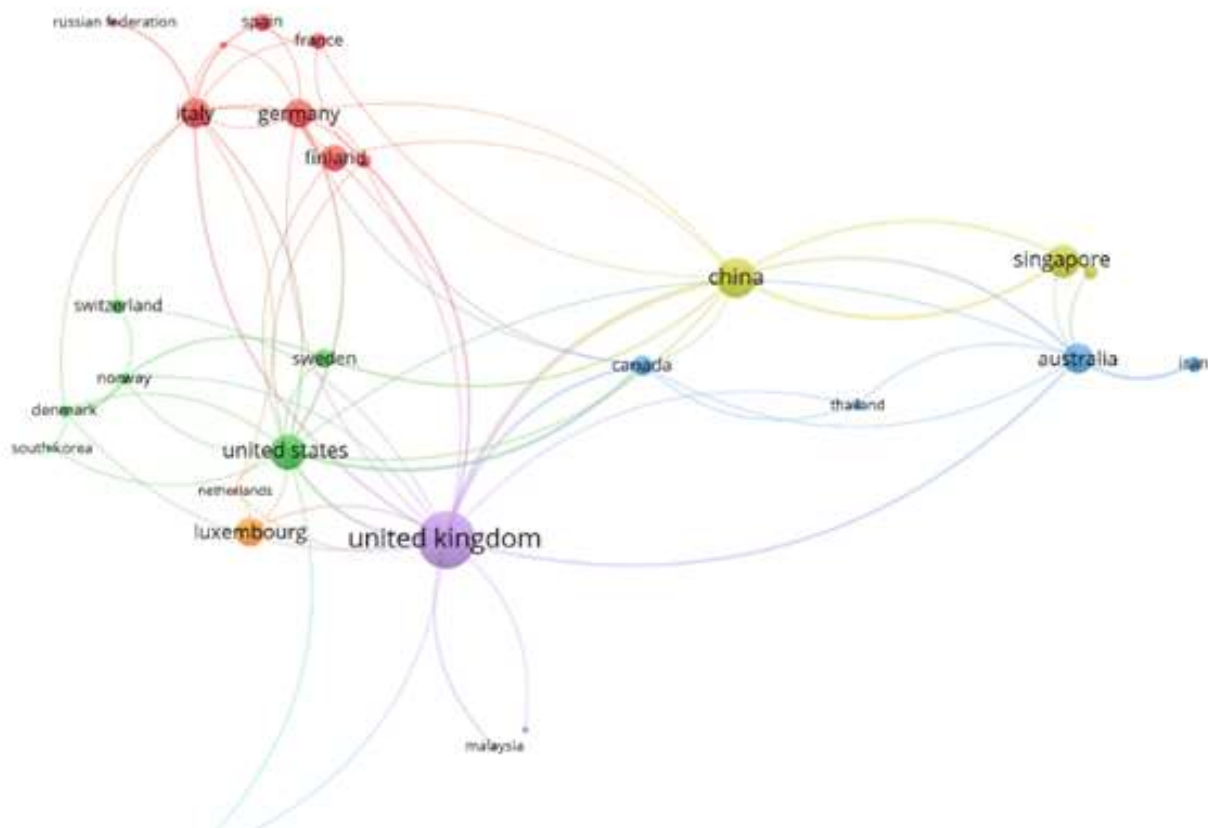


**Fig. 4.** Network Visualization of Countries showing the origin of the most cited research papers Courtesy VosViewer.
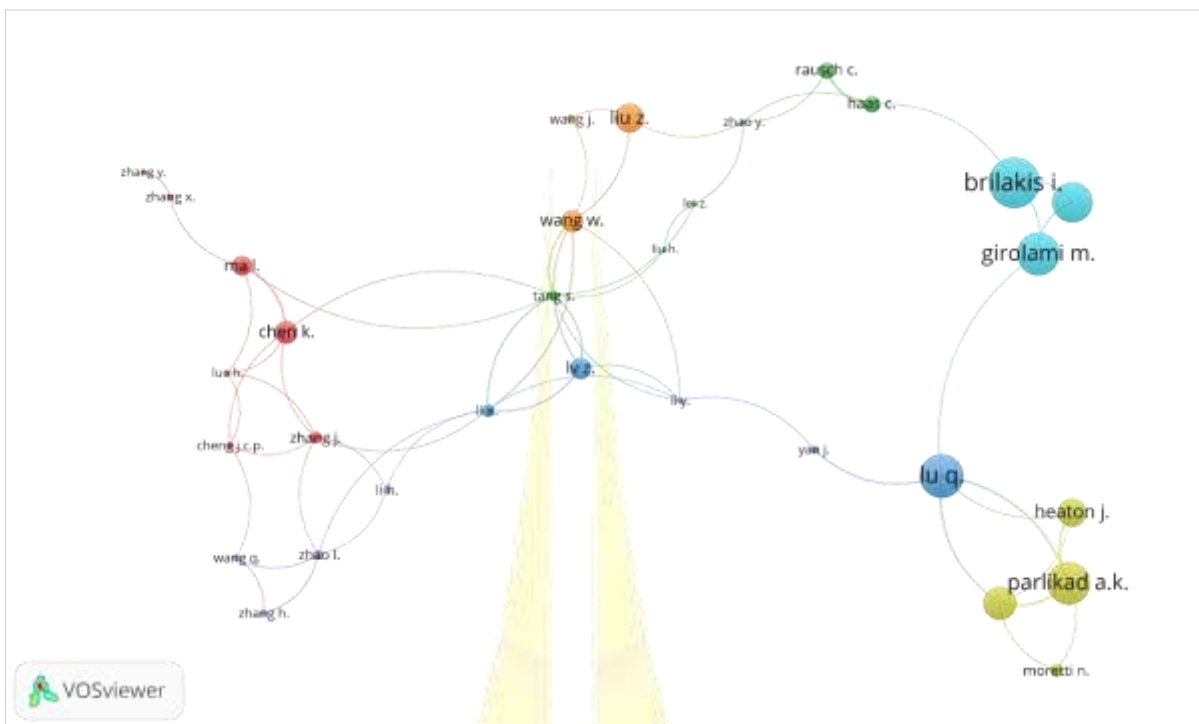
**Fig. 5.** Network Visualization of Co-Authorship network indicating the frequency of citations Courtesy VosViewer.
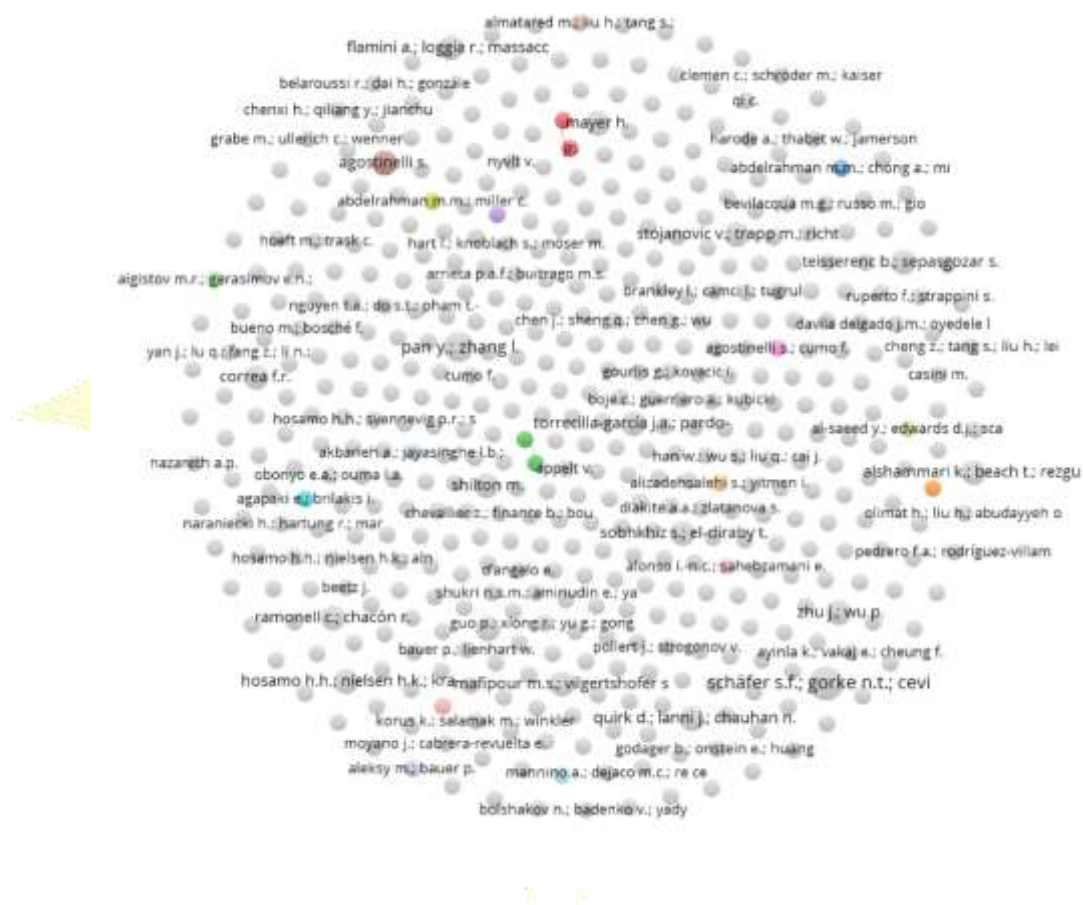


**Fig. 6.** Network Visualization of Co-Authorship network indicating low links Courtesy VosViewer.

Documents by author

Compare the document counts for up to 15 authors.
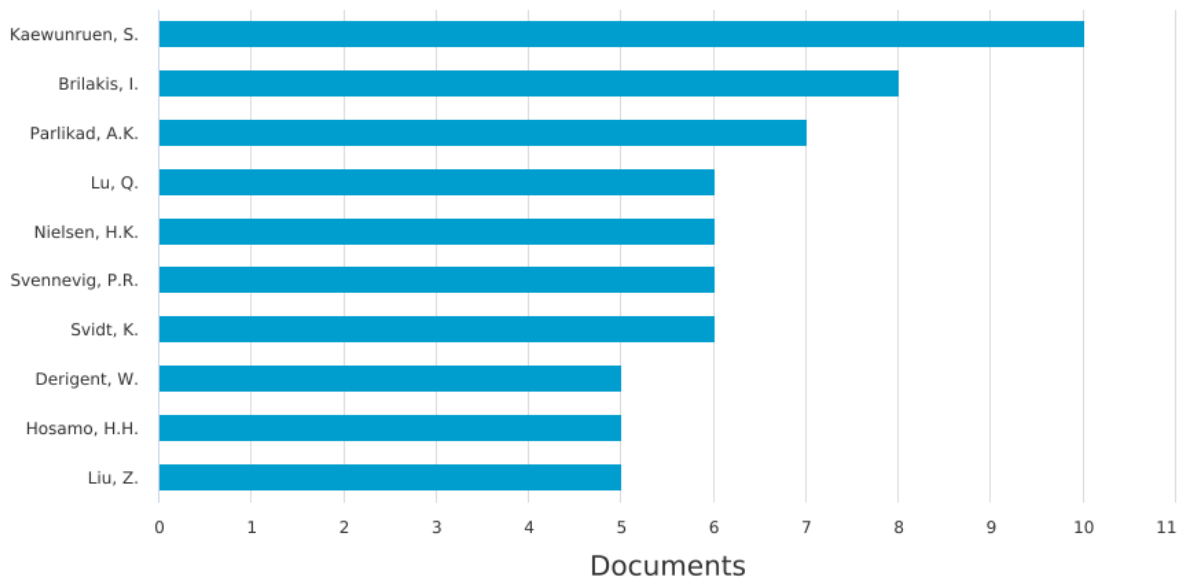
**Fig. 7.** Document Count of Authors.

## 5. CHALLENGES & OPPORTUNITIES

This section reiterates the barriers to the implementation of BIM-based DT for green retrofit already stated in the main body of the review. They are summarily the following:

1. Data Accuracy and Integration
2. Interoperability
3. Upfront Cost
4. The intricacy of building systems
5. Accuracy of BIM Model
6. Data Ownership and Security
7. Lack of Common Data tools and Standards

Heaton et al. (2019) also noted several challenges related to the use of BIM in the O&M phase, such as the difficulty of demonstrating its value, limited compatibility between BIM data and information management systems, and the need for O&M staff to learn BIM. To address this issue, their study focused on the transfer of BIM data into an Asset Information Model (AIM) as an alternative to learning BIM.

On a technical level, difficulties arise when attempting to link sensor data to entities in the Industry Foundation Classes (IFC) model. This is caused by the absence of universally accepted export regulations for IFC files, as well as the identification and avoidance of unreliable data sources, and the collection, preservation, and examination of data (Dave et al., 2018).

Sustainability assessment metrics currently use what Shoaib (2021), refers to as a static approach which requires a lot of documentation. He argues that digital twins can be used to offer a decision-making tool to interested parties, which is based on the actual performance of the building. By using the data generated by the digital twin, it is possible to obtain valuable information that can be used by designers, owners, researchers, and regulatory authorities for future planning purposes. The outputs of the digital twin can provide insights into the building's performance, allowing stakeholders to make informed decisions about the

building's design, operation, and maintenance.

For the Malaysian AEC industry, the first challenge that needs to be investigated is the parameters that qualify a property for BIM-based DT green retrofit due to the above-mentioned challenges. If brilliantly executed, the Malaysian AEC industry and academia can benefit from the global implementation of DT which is anticipated to grow exponentially, with its market estimated to increase from USD 6.9 billion in 2022 to USD 73.5 billion by 2027.

## 6. CONCLUSION & RECOMMENDATION(S).

The review has revealed that the research into the use of BIM-based Digital twins for retrofitting is still in its infancy and needs to be investigated further. The result of this study was determined via scientometric analysis and mapping of the research trend from 2018 to 2023 and it reveals that DT is a nascent concept in the Malaysian AEC industry and academia. Also, most ICT solutions discussed in the review are yet to be incorporated with BIM and that was one of the identified barriers to implementation.

However, the AEC industry will benefit from the adoption of BIM-based digital twins at post occupancy level and for retrofit decisions as real-time feedback on the performance of a building could be fed back to designers to make existing buildings more sustainable. AI and ML are potential drivers for this integration that need to be explored further. Summarily this review found at least three other areas that are recommended for future research. They include studies to explicate how varied BIM-based Digital twins can be used as decision support systems, Fault detection, and damage detection.

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# QUANTITY SURVEYING
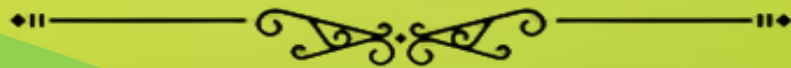
# POTENTIALS OF DIGITAL TECHNOLOGY CAPABILITY IN CONSTRUCTION INDUSTRY: A STUDY IN MANAGER'S LEVEL

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## ABSTRACT

Digital technology is an essential component of construction management. There are variety of digital technology, which evolves to highlight effective forms of life-cycle management, in ensuring the high profits in construction businesses. However, there is no thorough evaluation of the use and importance of digital technology that has been demonstrated to be beneficial in the administration of organizations. The degree of utilization of modern technology is also questionable due to the lack of a trustworthy source that can prove the relevance of a building enterprise. This limits the parties engaged in project management's ability to communicate directly with one another. Therefore, various digital technology are now capable of increasing collaboration virtually, increasing employee motivation and new ways of working on new norms however there are limited studies contributed to the development of positive digital technology implementation among management positions. The aim of the study is to assess the current level of digitalization in Malaysian construction organization followed by identification of important digital technology which can lead to positive digitalization from different view of all levels of construction workers. To accomplished this aim, a qualitative approach using questionnaires has been adopted with total of 462 questionnaires were distributed to top management, supervisory management and frontline management across the construction organization. Seventy four percent (74%) of the respondents respond successfully to the questionnaires. The analysis methods include the Gap Analysis and Krusskall-Wallis H Test Analysis. The result, connectivity element, text message, email, 5th generation broadband network, cloud storage and teleconferencing are utilized by all management positions to accommodate integrated functionalities in construction lifecycle management. It also indicates that emerging technology, digital automation, connectivity and digital access is crucial digital technology capability for all management positions to consider in their business innovation which involves personnel, organization and the ability of both small and large companies to manage such a disincentive digital technology.

*Keywords: Digital technology, management position, organization, construction industry*

## 1.0 INTRODUCTION

The construction industry is regarded as a complex yet crucial business on a global scale. According to Wang et al., (2022), within three years, the global construction market will reach the record level of 15 trillion dollars and will continue to grow at

a yearly rate of around 3% through to 2025. One of the key industries in Malaysia is construction, which is estimated to provide over 1.38 million jobs, account for 10% of all employment, and be worth over RM 27.7 billion (Zulkarnain et al., 2020). The essential requirement for digitalization is apparent, providing important benefits to assist intricate industries. For instance, digital transformation is taking place in the fields of finance, manufacturing, banking, and health care (Hossain & Nadeem, 2019) at a much slower pace in construction (Srivastava et al., 2021). An area where digitalization has made significant progress in the construction industry is the improved use of emerging technology (Smartsheet Inc., 2018), automation (Bello et al., 2021), connectivity (Alsunaidi et al., 2021) and digital access (John Ekechukwu, 2019). The current corpus of information claims that the construction industry's fragmentation prevents it from undergoing a more streamlined digital transition than other industries (Diana et al., 2019). The introduction of increasingly cutting-edge technologies like robotics and automated tasks signals the expansion of digitalization beyond routine daily tasks (Magnenat et al., 2012). This evolution is improving competence by reducing the margin of task errors through the capacity to learn and identify patterns (Martinez et al., 2018). According to alsunaidi et al., (2021), explains why it is necessary to concentrate on technical issues when examining digital manifestation in construction organisations. This is evidenced by (Aghimien et al., 2022), who document the vital improvements in performance, economy, and sustainability brought about by digital transformation in the digital age.

Mutual digital mindset and skillset by business leaders and managers have a significant impact on their organization's ability to embrace digital transformation. Hence, construction companies need to put awareness of Revolution Industry 4.0 at the forefront of their digitization efforts. Recent studies have shown how the deployment of digital technology has influenced organization business innovation. However, it is believed that in order for practice and academia to reflect various viewpoints, a bridge is required. It is believed that such an approach will reveal digital technology from an internal perspective as opposed to what the literature identifies externally at top management levels. Only a few studies have been done that specifically address the role of digital technologies play in fostering innovation in the construction industry (Berger & Schober, 2021; Ismail & Hassan, 2019; John Ekechukwu, 2019; Mehmet, 2018) not in line with the performance of organization. As a result, this paper makes a significant contribution to filling the research gap. The performance and importance of digital technology enactment in the construction business are thus explored in this study.

In contrast to other industries, the construction has few studies on digital technologies. The research body focuses mostly on education (Hapha & Somprach, 2019), health care (Martins, 2019) and governmental institutions (Nurafizah Amiruddin, 2019). However, there are very few studies that specifically address digital technologies that are applicable in procurements, logistics, construction, and marketing in the construction business. The slow rate of digital transformation in the construction industry calls for filling this knowledge gap and directing more research in a direction that is deemed essential. This will also provide the evidence needed to make wise decisions about how to overcome the barriers that stand in the way of an effective organization. Thus, four elements make up the indicated construction digital technologies enactment which is emerging technology, automation, connectivity and digital access.

This research is the part of digital leadership framework component which is digital technology capability as the preliminary studies of the scope of management position. This to ensure that all twenty-five construction digital technology in this studies is significant or

not in every level of management position in construction organization. According to (Jahanger et al., 2022; Rêgo et al., 2022; Schallmo & Tidd, 2021; Schwarzmüller et al., 2018; Tereshko & Rudskaya, 2021), construction organization in every firms has a unique life-cycle management in executing business innovation planning, strategy and development. This leads to digital technology as an enabler of business model innovation to improve leaders and followers skills to do a daily task that is more complex and difficult to perform by help out from automated in accelerating management (Chen et al., 2022). Therefore, the purpose of this study is to assess the current level of digitalization in Malaysian construction organization followed by identification of important digital technology which can lead to positive digitalization from different view of all levels of construction workers.

## 2.0 RESEARCH METHODOLOGY

This research considers the perceptions of construction stakeholders to investigate the current practice of digital technologies in Malaysia. A questionnaire survey was selected as a research approach because of its ability to provide rigid information from the variety hierarchy respondent's perspectives and the results will also give insight on the causal relationship between variables studied (Apuke, 2017), which in this case is digital technology implementation.

According to the Department of Statistics Malaysia in 2022 there are 2,173,400 workers employed in the construction industry. A total of 462 samples have been selected randomly from the employees in the construction industry based on a set of criteria representing not only contractors but also state-owned enterprises, associations and professionals. These criteria include a year of experience, holding management positions and experience in digital technologies in daily scope of work. There are categories into three-hierarchy stewardship which is top

management, supervisory management and frontline management where indicate the role of each position against the scope of the work performed. This is to determine that each level of management has digital technology that is interested in the scope of daily work. Based on Godden (2004), the number of samples is enough to represent the population studied. The research excluded international experts to generate consistency and a similar understanding of potential and culture in the country (Abdul et al., n.d.; Simanjuntak, 2021).

*Table 1* Questions instruments

| Questions | Cue for Analysis |
|---|---|
| Do you used digital technologies within the scope of your work? | The most significant digital technology used, current level of digitalization in management position. |
| Is it important to used digital technologies within the scope of your work? | The most importsnt digital technology for future development, digital technology perception. |

This research used a closed-ended questionnaire through dual-Likert scale to respond to the research objectives from the literature review outcomes. This approach allows respondents to reply to questions on their terms and provide the agility of interaction due to the researcher's experience and opinions to interact and validate replies on a particular topic (von Elm et al., 2004). To maintain a focus on specific topics or issues, it is essential to prepare questionnaire that respondents easy to understand without jargon words or elusive statement to generate similar feedback from respondents for analysis (Lopez & Whitehead, 2013). Twenty-five digital technology as instrument of the questionnaire survey is shown in Table 1.

The research analysed the samples through gap analysis and Kruskal-Wallis H Test. First, the mean of implementation and important for twenty-five digital technologies was assessed through SPSS software then being calculate the gap to

generate meaning and corroboration. Second, the quantitative data were evaluated using descriptive statistics to map the overall three category of hierarchy management position relies with twenty-five digital technology.

# 3.0  FINDINGS

## 3.1  Sampling and Data Collection

The respondent's background was categorised into four subjects, including occupation, field of work, respondent role and experience. Out of 341 respondents successful completing the questionnaire form, the result showed that 16.42% work in developer, 21.11% work in consultant, 39.88% work in enterprise of the construction sector, 7.04% as local authority, 4.11% as suppliers and 11.43% in programmer, freelance and professionals. As far as respondent industry is concerned, most of them 55.42% supervisory management and 25.22% top management as highest participant compared to frontline management 19.35%. The respondents have more than five years of experience in Malaysia's construction sector only 9.38% while less than three years of experience is 39.58%. The demographics of the respondents can be found in Table 2.

**Table 2** Ranking of elements by mean value for every respondent designation

| Category of Company | Frequency | % |
|---|---|---|
| Developer | 56 | 16.42 |
| Consultant | 72 | 21.11 |
| Contractor (Big/ SME) | 136 | 39.88 |
| Local Authority | 24 | 7.04 |
| Suppliers | 14 | 4.11 |
| Others | 39 | 11.43 |
| Total | 341 | I00.00 |
| **Management Position** | **Frequency** | **%** |
| Top Management | 86 | 25.22 |
| Supervisory Management | 189 | 55.42 |
| Frontline Management | 66 | 19.35 |
| Total | 341 | I00.00 |
| **Respondent Role** | **Frequency** | **%** |
| Chairmain/ Director | 81 | 23.75 |

| | Frequency | % |
|---|---|---|
| Executive Manager | 192 | 56.30 |
| Site Manager | 68 | 19.94 |
| Total | 341 | 100.00 |
| **Years of Experience in Construction** | **Frequency** | **%** |
| ≤ 3 | 135 | 39.58 |
| 3 to 5 | 80 | 23.46 |
| 6 to 10 | 64 | 18.76 |
| 11 to 15 | 30 | 8.79 |
| > 15 | 32 | 9.38 |
| Total | 341 | 100.00 |

## 3.2  Construction Digital Technology (Three hierarchy management position)

This section describes the twenty-five digital technology implemented by all level of construction workers in the Malaysian construction industry. The results were based on different types management positions. The results were very important to seek the understanding whether different group of workers perceived the same digital technology that affect their utilization. This distinction will give a construction team knowledge on suitable and effective intervention strategies that can be implemented into their construction organization.

**Table 3** Ranking of elements by mean value for every respondent position

| | Construct | Top Management | | Supervisory Management | | Frontline Management | |
|---|---|---|---|---|---|---|---|
| | | Mean | Rank | Mean | Rank | Mean | Rank |
| E1 | Productivity Software (PlantGrid, Kahua, RedTeam) | 3.49 | 16 | 3.63 | 13 | 3.36 | 13 |
| E2 | Analytic/ Big Data (Risk Analysis Software) | 3.77 | 11 | 3.71 | 11 | 3.52 | 11 |
| E3 | Internet of Thing (Just-In-Time, E-supplier) | 4.09 | 6 | 3.85 | 8 | 3.82 | 6 |
| E4 | Artificial Intelligence (Analytics technology) | 3.33 | 19 | 3.39 | 20 | 3.06 | 17 |
| E5 | Block Chain (Smart Contract) | 3.07 | 23 | 3.37 | 22 | 2.88 | 18 |
| A1 | Robotic Process (Excavation Robots, Bricks Robots) | 2.72 | 24 | 2.94 | 25 | 2.24 | 25 |

| Code | Technology | | | | | |
|------|-----------|------|------|------|------|------|
| A2 | Additive Manufacturing (3D model house) | 2.72 | 25 | 2.97 | 24 | 2.55 | 22 |
| A3 | Augmented Reality/Virtual Reality /Mixed Reality | 3.21 | 21 | 3.47 | 18 | 3.45 | 12 |
| A4 | Drone Technology | 3.63 | 13 | 3.83 | 9 | 3.61 | 9 |
| A5 | Pre-Fabrication/ Modular Construction | 3.12 | 22 | 3.34 | 23 | 2.52 | 23 |
| C1 | Data collection Apps (e-suppliers, marketing apps) | 3.47 | 17 | 3.55 | 16 | 2.70 | 21 |
| C2 | Integrations with other services (goggle sheet, docs) | 3.98 | 8 | 4.11 | 6 | 3.79 | 7 |
| C3 | Internet of Things (RFID tag, IoT sensor) | 3.86 | 9 | 3.89 | 7 | 3.79 | 8 |
| C4 | Teleconferencing (Video, Call) | 4.35 | 4 | 4.28 | 3 | 4.00 | 4 |
| C5 | Block Chain (Labour market, ease payment) | 3.81 | 10 | 3.71 | 12 | 3.58 | 10 |
| C6 | Cloud Storage (Dropbox, Google Drive, One Drive) | 4.37 | 2 | 4.32 | 2 | 4.12 | 2 |
| C7 | Big Data (Text message, Skype, Emails) | 4.23 | 5 | 4.19 | 5 | 3.94 | 5 |
| D1 | Integrating by AI/ Software (Bimsync) | 3.67 | 12 | 3.53 | 17 | 3.21 | 15 |
| D2 | Scheduling Software (Microsoft Project, Primavera) | 4.00 | 7 | 3.82 | 10 | 3.30 | 14 |
| D3 | Estimation Software (Cubicost, Buildxact, Redteam) | 3.60 | 15 | 3.46 | 19 | 2.85 | 19 |
| D4 | Technology for 3D modelling (BIM, Revit, Cubicost) | 3.28 | 20 | 3.61 | 14 | 2.45 | 24 |
| D5 | Collision Detection Software (BIM Clash detection) | 3.35 | 18 | 3.38 | 21 | 2.73 | 20 |
| D6 | Web conferencing (Google Meet, Webex) | 4.37 | 3 | 4.28 | 4 | 4.09 | 3 |
| D7 | SaaS Construction Software (Novade, Dropbox) | 3.63 | 14 | 3.56 | 15 | 3.18 | 16 |
| D8 | Smart Phone (Social media/ e-payment) | 4.44 | 1 | 4.37 | 1 | 4.18 | 1 |
| | Average | 3.66 | | 3.70 | | 3.32 | |

The analysis on Table 3 continues to look into the difference on digital technology between different management position. According to the top management, three top digital technology that ususally utilized in their works are smart phone (4.44) followed by cloud storage (4.37) and web conferencing (4.37). The top two digital technology also agreed by the supervisory and frontline management group with a mean value of 4.37 and 4.18 respectively for smart phone and cloude storage with mean value of 4.32 and 4.12. According to the supervisory management, the main digital technology that influence their routine job about managing is the teleconferencing (4.28) followed by big data (4.19) and integration with other services (4.11) such as goggle sheet, docs.

On the other hand, the least digital technology are as follows; according to the top management, the least digital technology which utilized in their daily job of scope are smart contarct (3.07) followed by robotic processes (2.72) and addictive manufacturing (2.72). According to supervisor staff, consultants and general workers, digital technology that are least affected in the daily work is modular construction, addictive manufacturing and robotic process with 3.34, 2.97 and 2.94 respectively. Besides, modular construction (2.52), BIM (2.45) and Robotic process (2.24) also the least important digital technology which may contribute to the daily implementatation among the Malaysian construction workers with lower value from site supervisor and site manager. Therefore, it is very important to look back into what currently is being implemented on site in terms of digital technology to make sure the strategies and resources have been used properly and effectively.

## 4.0  DISCUSSION

### 4.1    Current Level of Digitalization in Malaysian Construction Organization Among Different Group of Management
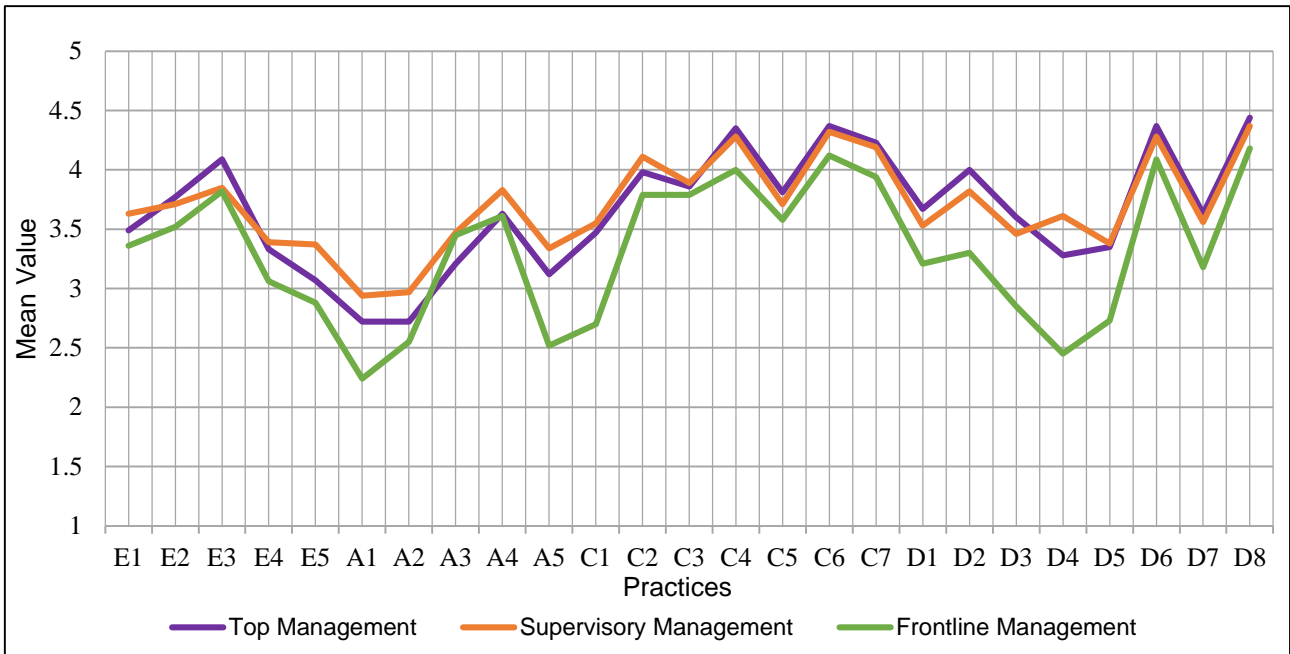
**Figure 1** *Overall mapping for average mean value for every management position*

This section describes the digital technology implementation in the Malaysian construction organization. The results were based on different types of workers. The results were very important to seek the understanding whether different group of workers perceived the same diigital technology that affect their utilization in daily job scope of work. This distinction will give a construction team knowledge on suitable and effective intervention strategies that can be implemented into their construction organization.

Figure 1 show the overall mapping for average mean value for three management position where represent four element digital technology which is five of emerging technology (E1 - E5), five of digital automation (A1 - A5), seven of connectivity (C1 - C7) and eight of digital access technology (D1 - D8).

**Table 4** Kruskal-Wallis H Test Result (Ranks)

| | Management Position | N | Mean Rank |
|---|---|---|---|
| Digital Perception | Top Management | 86 | 175.93 |
| | Supervisory Level | 189 | 183.71 |
| | Site Management | 66 | 128.17 |
| | **Total** | **341** | |

### 4.2 Krusskall-Wallis H Test for Practices of Digital Technologies in Malaysian Construction Organization

A Kruskal-Wallis H test result from Table 4 and Table 5 showed that there was a statistically not significant difference in digital technology implementation between the different management position, $\chi 2(2) = 15.848$, p = 0.310, with a mean rank digital perception of 175.93 for top management, 183.71 for supervisory management, and 128.17 for frontline management. In conclusion, there are no significant difference between perceived digital technology implementation between three group of workers in this study. Thus, digital technology capability is relevant for all construction organization in both small and big companies to perform digital leadership framework as business model innovation as there is no significant different in terms of implementation and practices for three level of management position.

**Table 5** Kruskal-Wallis H Test Result (Test Statistics)

| | Digital Perception |
|---|---|
| Chi-Square | 15.848 |
| df | 2 |
| Asymp. Sig. | .310 |

a. Kruskal Wallis Test
b. Grouping Variable: Management Position

## 5.0 CONCLUSION AND RECOMMENDATION

This study found that the majority of the respondents agreed that feedback on digital technology played an important role in their life-cycle management and is also needed for its further improvement. Thus, it is recommended that strategies management team nor new business model innovation should consider to expending the development of digital technology improvement in their system in their daily organization routine.

Meanwhile, the majority of the respondents agreed that the management team did not do well in providing incentives to their workers especially regarding the utilization of emerging technology and digital automation regarding as the needed of high capital and still its infancy in Malaysia construction industry. This is shown by the bigger number of negative gap value. The respondents believed that the management team did not put incentives as the major contributors that may help in increasing worker's spirit to perform the job efficiency and actively contribute to digital technology issues. According to the top management and supervisory, the team needed to further improve their digital management system and control the high strategies technology among workers.

The consultants have a different view on the digital technology that needed to be reviewed. They agreed that the concern of the management team regarding digital technology and establishment suitable incentives system was much needed.

In conclusion from Figure 1, the gap analysis shows the overall mean value for digital technology practices status undertaken in this study. Suitable incentives on digital technology and controlling strategy at the workplace are two major concerns from the frontline

worker's perspectives. Overall, the smaller number in the negative gap value shows that the current level of digitalization in Malaysian construction organization is still in its infancy where moving in the right track and would positively contribute to good digital technology performance in every level of management position. Thus, digital technology capability is relevant for all construction organization in both small and big companies to perform digital leadership framework as business model innovation.

Further studies may include but are not limited to the digital technology on site required by the industry, considering the scope of the project, the procedure to implemented new strategies and a more in-depth analysis of the independent institution as the digital technology experience and capital needed based in both small and large companies opportunities.

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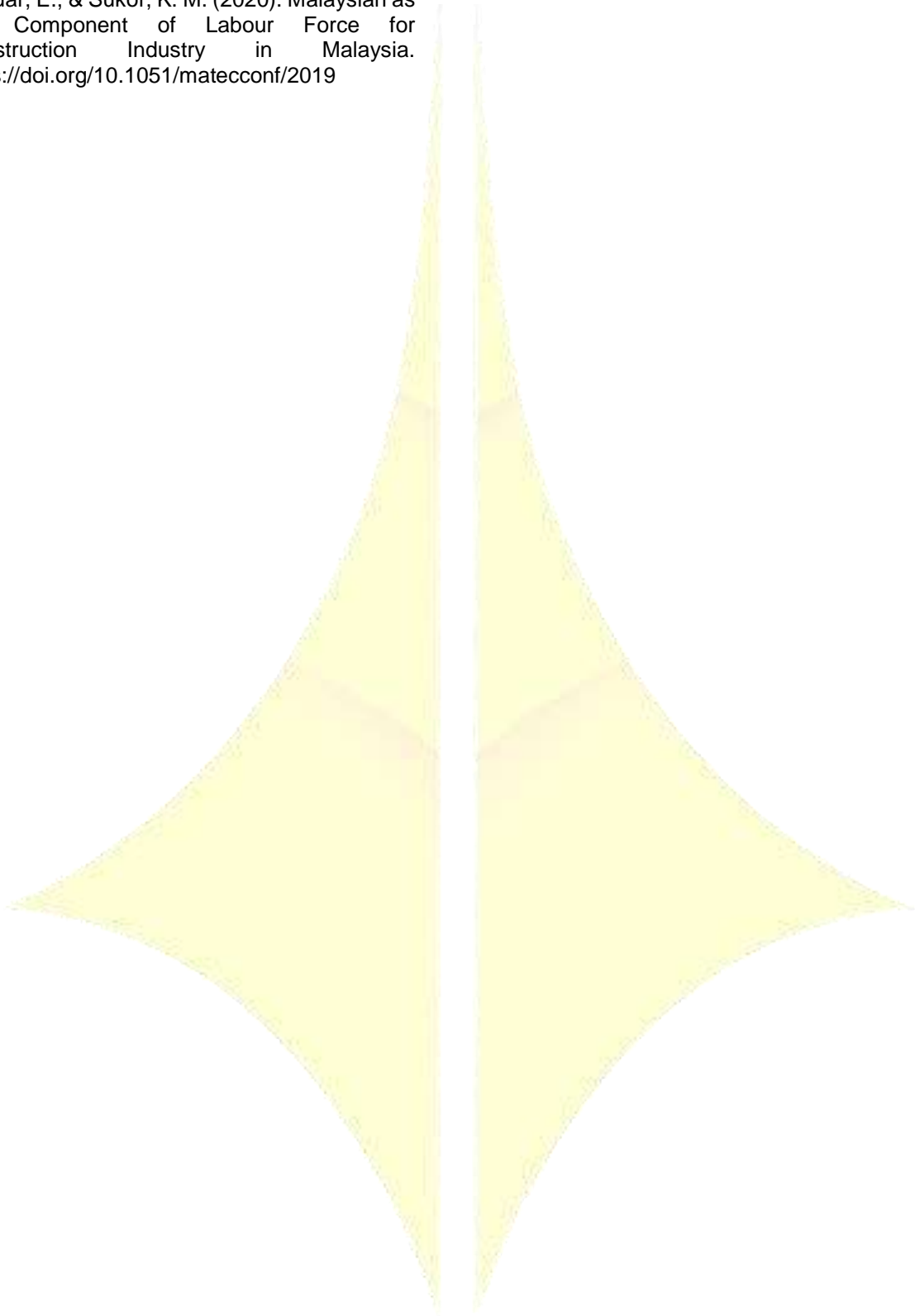
# DEVELOPMENT OF MODEL FOR SUSTAINABLE SANITARY FACILITIES DESIGN IN PUBLIC BUILDINGS IN MALAYSIA

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## ABSTRACT

Queuing is a social norm as a courtesy for other people who are waiting for the same service, especially in sanitary facilities. Studies show long queues have led to long waiting times at sanitary facilities, especially at female toilets. It also shows that the average waiting time for females decreased when the number of cubicles increased. It happened because of clothing, pregnancy, menstruation, and more. Also, females spend twice as many times compared to males. Gender-specific toilets (female and male toilets) designs are inappropriate for females as the guidance and codes are mostly administered by males. A study by van Hautegem and Rogiest (2017) reveals shared sanitary facilities (gender-neutral and unisex toilets) can decrease the average waiting times for females. This is because the average waiting times are equal for all users. The objectives of this research are to identify problems and determine components and criteria of existing gender-specific toilets by facility design requirements. Plus, to establish facilities design requirements' perception and acceptance of gender-specific toilets and shared sanitary facilities to produce good design models. The research scope focuses on the built environment and human behaviour. Here, mixed research methods are applied in the methodology for this research. Ethnography survey by implementing questionnaires to identify problems and to determine components and criteria of existing gender-specific toilets by facilities design requirements. The discussions and interviews are performed to establish facilities design requirements' perceptions and acceptance of gender-specific toilets and shared sanitary facilities. All the collected data is analysed using SPSS and ATLAS.ti. Analysed data from quantitative and qualitative research methods were connected and merged to develop a model design for sustainable sanitary facilities in public buildings. The results inform the best model design of a sanitary facility that satisfies all users by facilities design requirements based on the methodology involved. The research can provide the best solutions not only for females and males but also for users with special conditions and needs. The research can improve conditions and the number of sanitary fittings and facilities in public buildings based on the results collected from volunteer participants.

*Keywords : sanitary facilities, sustainable sanitary facilities design, cultural influence, public buildings*

# DESIGN FOR SAFETY (DFS) IN CONSTRUCTION INDUSTRY

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## ABSTRACT

Occupation safety and health (OSH) can be considered as one of the crucial issues that need to be addressed by stakeholders. This was due to the frequency of accidents that occur in the construction industry. These circumstances could have effects on workers, organisations, society, and the construction industry as a whole. There were studies which stated that by integrating safety and health element at the early stage of a construction project could reduce the possibilities of hazard and accident to occur. This concept was known as Design for Safety, which specifically looking into safety matters at the design stage as a way to reduce occupational safety and health hazards. This study aim to review the current state of this Design for Safety concept at the design stage of a construction project and identify its significant areas in the current research. Bibliometric review was carried out to review related publications to the topic. 33 and 58 papers found on Web of Science and Scopus respectively were included in this review. The focus of literature search is between 2019 and 2022. The search was dependent on the following keywords: TOPIC: "Design for safety" OR "Prevention through Design" OR "Safety by Design" OR "Construction (Design and Management) Regulations" OR "Occupational Safety and Health in Construction Industry (Management)" OR "DfS" OR "SbD" OR "OSHCIM" OR "PtD" AND TOPIC "construction industry". More research is required on Design for Safety in order for it to be fully established and assimilated within the construction industry worldwide.

*Keywords : Health and Safety, Design for Safety, Occupational Safety and Health, Occupational Safety and Health in Construction Industry (Management), Construction Industry*)

## INTRODUCTION

According to the DOSH, the construction industry has the greatest fatality rate when compared to other industries such as manufacturing and agriculture. SOCSO and DOSH statistics reveal that the number of fatal accident cases has increased by 231.9% and 125.8%, respectively, during the previous five years. Unsafe procedures, the unique nature of the industry, and job site circumstances are the top three causes of fatal construction accidents. The construction industry must consider safety matters during the design stage to

eliminate and substitute the hazards in order to reduce the risk for the whole life cycle of the building project (Samsudin et al., 2021). Most of the risk prevalent problem in construction industry which led to casualties and fatalities are preventable if the risks in the construction are well known at the earlier stage of construction. (Onyeka & Agunwamba, 2019).

This research aimed to review the current state of this Design for Safety concept at the design stage of a construction project and identify its significant areas in the current research while enhancing the existing knowledge of DfS in construction industry.

In this review-based study, the bibliometric mapping study method and scoping review technique was adopted to provide a systematic and holistic review of Design for Safety in the current construction industry. Bibliometric studies of papers published from 2019 to 2023(July 2023) in Web of Science and Scopus was collected.

The current research indicates that increasing adoption of DfS in construction industry due to the capability of DfS to identify potential hazard during design stage. Corrective measures and preventive actions can be taken before fatal incidents with DfS. This begins early, which is in the design phase thus, the designer team must be accountable for safeguarding worker safety and health, establish a communication system to disseminate OSH-related information to everyone, and efficiently manage OSH concerns with the members of the construction team. Therefore, the design team will inform all stakeholders of risk during the design stage through their design and risk register report (Mohd et al., 2020).

## MAIN RESULTS

In order to find the structure and trends for the query "Design for safety" OR "Prevention through Design" OR "Safety by Design" OR "Construction (Design and

Management) Regulations" OR "Occupational Safety and Health in Construction Industry (Management)" OR "DfS" OR "SbD" OR "OSHCIM" OR "PtD" AND TOPIC "construction industry" we first started with a more general theme to identify, evaluate, and analyse the published papers. These were the most widely used keywords for Design for Safety at this time, according to the detected publications, and they could be grouped into two clusters, as shown in Figures below.

Figure 1 below shows the most co-occurring keyword search related to "Design for safety" OR "Prevention through Design" OR "Safety by Design" OR "Construction (Design and Management) Regulations" OR "Occupational Safety and Health in Construction Industry (Management)" OR "DfS" OR "SbD" OR "OSHCIM" OR "PtD" AND TOPIC "construction industry" in Scopus with the minimum number of occurrence of keywords being at least six occurrences. From 536 keywords, 17 met the threshold. For each of the 17 keywords, the total strength of the co-occurrence links with other keywords was generated.

Figure 2 below shows the most co-occurring keyword search related to "Design for safety" OR "Prevention through Design" OR "Safety by Design" OR "Construction (Design and Management) Regulations" OR "Occupational Safety and Health in Construction Industry (Management)" OR "DfS" OR "SbD" OR "OSHCIM" OR "PtD" AND TOPIC "construction industry" in Web of Science with the minimum number of occurrence of keywords being at least five occurrences. From 185 keywords, 14 met the threshold. For each of the 14 keywords, the total strength of the co-occurrence links with other keywords was generated.

The overall strength of the co-occurrence links with other keywords was generated for each of the chosen keywords. Only the keywords with the strongest overall link

profile were chosen. In order to identify the research topic, co-occurrence is the phrase used to define the proximity of keywords in the title, abstract, or keyword list in publications. The connection shows how frequently they occur.

Table 1 and 2 shows the most common co-occurring keywords of "Design for safety" OR "Prevention through Design" OR "Safety by Design" OR "Construction (Design and Management) Regulations" OR "Occupational Safety and Health in Construction Industry (Management)" OR "DfS" OR "SbD" OR "OSHCIM" OR "PtD" AND TOPIC "construction industry" in Scopus and Web of Science respectively.
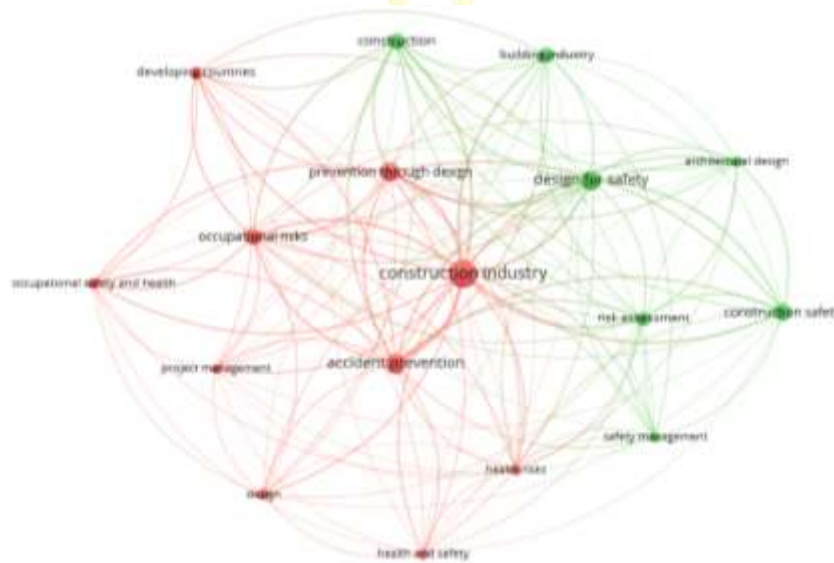


**Figure 1** The most commonly co-occurring keyword search related to "Design for safety" OR "Prevention through Design" OR "Safety by Design" OR "Construction (Design and Management) Regulations" OR "Occupational Safety and Health in Construction Industry (Management)" OR "DfS" OR "SbD" OR "OSHCIM" OR "PtD" AND TOPIC "construction industry" in Scopus, with 58 publications.

**Table 1** Most common co-occurring keywords in Scopus

| Keywords | Cluster | Links | Total Link Strength | Occurrence |
|---|---|---|---|---|
| Construction Industry | 1 | 17 | 233 | 44 |
| Accident Prevention | 1 | 17 | 148 | 23 |
| Design for Safety | 1 | 17 | 129 | 23 |
| Prevention through Design | 2 | 17 | 126 | 22 |
| Occupational Risks | 3 | 17 | 117 | 16 |
| Construction | 2 | 16 | 105 | 15 |
| Building Industry | 2 | 17 | 86 | 14 |
| Construction Safety | 2 | 16 | 78 | 17 |
| Developing Countries | 3 | 17 | 72 | 9 |
| Risk Assessment | 1 | 17 | 68 | 11 |
| Architectural Design | 2 | 17 | 55 | 8 |
| Occupational Safety and Health | 1 | 17 | 53 | 8 |
| Health risks | 3 | 15 | 46 | 6 |

| | | | | |
|---|---|---|---|---|
| Design | 3 | 16 | 40 | 8 |
| Project Management | 2 | 16 | 40 | 6 |
| Safety Management | 2 | 16 | 40 | 6 |
| Health and Safety | 1 | 15 | 35 | 6 |
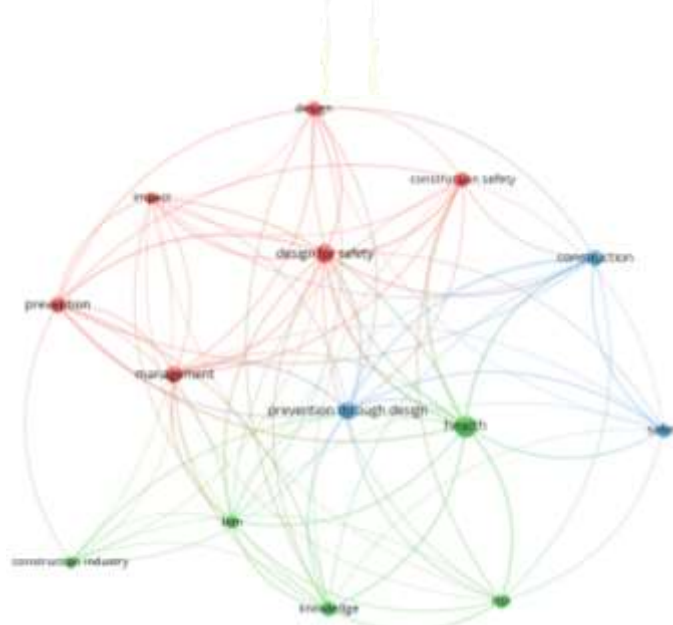


**Figure 2** The most commonly co-occurring keyword search related to "Design for safety" OR "Prevention through Design" OR "Safety by Design" OR "Construction (Design and Management) Regulations" OR "Occupational Safety and Health in Construction Industry (Management)" OR "DfS" OR "SbD" OR "OSHCIM" OR "PtD" AND TOPIC "construction industry" in Scopus, with 33 publications

**Table 2** Most common co-occurring keywords in Web of Science

| Keywords | Cluster | Links | Total Link Strength | Occurrence |
|---|---|---|---|---|
| Health | 2 | 13 | 60 | 17 |
| Design for Safety | 1 | 13 | 54 | 13 |
| Prevention through Design | 3 | 13 | 45 | 12 |
| Construction | 3 | 11 | 36 | 9 |
| Prevention | 1 | 11 | 37 | 9 |
| Construction Safety | 1 | 12 | 34 | 8 |
| Knowledge | 2 | 13 | 35 | 8 |
| BIM | 2 | 13 | 31 | 6 |
| Management | 1 | 12 | 31 | 10 |
| Risk | 2 | 11 | 28 | 7 |
| Design | 1 | 11 | 28 | 8 |
| Impact | 1 | 12 | 25 | 5 |
| Safety | 3 | 10 | 21 | 7 |
| Construction Industry | 2 | 9 | 13 | 5 |

Cluster Safety and Risk Management

| | | |
|---|---|---|
| Prevention | Occupational Risks | Design for Safety |
| Health | | |
| Construction Safety | Risk Assessment | Prevention Through Design |
| Safety | Accident Prevention | Health Risks |
| Health and Safety | Risk | Occupational Safety and Health |

Cluster Construction and Design

| | |
|---|---|
| Construction Industry | Construction |
| Safety Management | Design |
| Project Management | BIM |
| Architectural Design | |
| Building Industry | |

## DISCUSSION

This assessment has given a general overview of Design for Safety in the construction sector over the last five years, while not thorough. The selected papers showed the current state of DfS, such as. The conceptual value of DfS to the construction industry is all that is addressed in the targeted papers. To comprehend the advantages DfS offers the construction sector, a thorough study must be conducted. Studies on management are also limited.In order for DfS to succeed in the market, further research is required.

The first cluster is cluster safety and risk management which includes prevention, health, construction safety, safety, health and safety, occupational risks, risk assessment, accident prevention, risk, Design for Safety, Prevention through Design, health risks and Occupational Safety and Health. This cluster encompasses various interconnected concepts, all of which play a crucial role in promoting a safe working environment and protecting the well-being of construction workers and stakeholders. It highlights the importance of proactive measures, collaboration between designers and construction teams, and the integration of safety considerations at all stages of a construction project. By understanding and implementing these principles, safer working environments can be created and the incidence of workplace accidents and health issues can be reduced.

The second cluster includes construction industry, safety management, Project management, architectural design, building industry, construction, design and BIM. This cluster emphasizes the significance of integrating safety considerations into the design and construction processes to create safer and more efficient construction projects

Due to a profound level of consciousness and positive disposition towards the idea of Design for Safety (DfS) among construction designers in certain countries, they actively participate in implementing DfS. This indicates a distinct relationship between DfS awareness, attitude, and engagement. A notable disparity between these countries lies in the creation of regulatory rules for DfS, exemplified by Malaysia's OSHCIM rules, which sets them apart from other emerging nations such as Ghana, Nigeria, and Palestine, where no such regulations have been reported (Christermaller et al., 2022).

## CONCLUSION

The author suggests the government incentives as a catalyst for enhancing the practicability and adoption of Design for Safety (DfS) in the construction sector which underscores the pivotal role of policy support in advancing safety standards. However, it is crucial to acknowledge the methodological limitations inherent in this study, primarily centered around the bibliographical analysis approach, which may not capture the distinction of real-world

implementation. Exploring these points in depth will provide valuable insights into the importance of safety in the construction industry and the role of Design for Safety and related concepts in mitigating risks and promoting a safer work environment to propel DfS into a more profound and actionable realm. Future research should focus towards exploring the integration of cutting-edge technologies like Building Information Modeling (BIM) in the implementation of DfS. By bridging the gap between theory and practicality, such studies have the potential to not only strengthen safety practices but also revolutionize the construction industry's approach to risk management and worker well-being.

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# TRANSACTION COST ECONOMICS APPLICATIONS IN HOUSING DEVELOPMENT: LIMITATIONS AND STRATEGIES FOR MITIGATION

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## ABSTRACT

Transaction Cost Economics (TCE) has proven its good merits through successful applications by various industries as TCE is perceived to be beneficial in analyzing the cost-effectiveness of economic activities and performances. Realizing its potentials, several research adopted the theory in their construction management practice. As no theory deemed to be perfect, TCE adoptions in construction management faces challenges which requires adjustments to suit its special characteristics. Currently, the significant TCE limitations within the Construction Industry adoption stemmed from the difficulties in TCE quantification due to contradictions in the definition of the transaction costs itself. Hence, this paper attempts to delineate the theoretical research background on previous applications of TCE and analyze on how TCE is applied in the quest to mitigate TCE's limitations and challenges. Findings from this study will be able to establish mitigating strategies for efficient TCE adoption in Construction Industry generally and in Housing Development specifically. This paper focuses on the research approach, research technique as well as research analysis by various successful researchers on TCE studies where the findings will be able to suggest practical approaches for future TCE application in Construction Industry generally and Housing Development specifically.

*Keywords : Transaction Cost Economics (TCE), Construction Industry, Housing Development, Limitations, Mitigations*

## INTRODUCTION

Transaction costs was initially introduced by Ronald Coase in 1937 as 'the costs of using the price mechanism in the market' and this concept was further elaborated by Oliver Williamson, who introduced Transaction Cost Economics (TCE) theory in 1981. Williamson defined transaction costs as the costs of running the economic system and it comprises (i) searching and information costs; (ii) bargaining and decision costs; and (iii) policing and enforcements costs (Williamson, 1981; Dyer, 1997; Liang & Huang, 1998; Wink Junior et al., 2011; Zainuddin et al., 2021). Transaction Cost Economics can be further categorized into (i) pre-contract or post-contract; (ii) fixed or variable; and (iii) visible (transparent) or hidden (non-transparent) (Zainuddin et al., 2021; Li et al., 2014; Kissell, 2013). By elaborating the definition of the TCE categorization, it assists in coordinating and improving the

redundant transaction activities as TCE is an economic tool that coordinate mechanisms (Cho, 2011), assists in decision making and provides a platform to allow parties to have better understanding towards the hidden costs associated with project work (Rajeh et al., 2013).

Transaction Cost Economics (TCE) has steadily proven its good merits through successful applications by various industries as TCE is beneficial in analyzing the cost-effectiveness of economic activities and performances. Realizing its potentials, the Construction Industry also took the opportunity to adopt the theory within their construction management practice. As advised by previous studies, transaction costs analysis is necessary since it enhances costs transparency because transaction costs in comparison with actual construction costs are relatively obscure, and how they are incurred in each stage of development is not well-understood (Qian, Chan & Khalid, 2015) and disregarding transaction costs may result in inefficient framework (Yoshimoto, 1995).

As no theory deemed to be perfect, TCE adoptions in construction management faces challenges which requires adjustments to suit its special characteristics. Hence, this paper attempts to delineate the theoretical research background on previous applications of TCE and analyze on how TCE is applied in the quest to mitigate TCE's limitations and challenges for future TCE application in Construction Industry and Housing Development.

## MAIN RESULTS

### 2.1 Research Methodology

The theoretical research background is carried out through a Systematic Literature Review to determine the possibility of TCE adoption in Construction Industry generally and Housing Development specifically. Systematic Literature Review assists with several aspects of the research process such as establishing a context, seeking theoretical support, distinguishing what has been done from what needs to be done, identifying the main outcomes and methodologies used in prior studies as well as avoiding unproductive research (Linnenluecke et al., 2017). The review utilizes the Bibliometric Analysis and is conducted using Visualization of Similarities (VOS) Viewer software to visualize the findings and to be able to provide systematic ways to map knowledge developments over time, as well as trends of topics of interest in the research literature (Linnenluecke et al., 2020).

Recommendations to mitigate the TCE's limitations was derived from systematic literature review as well as case studies interviews to further support the systematic literature review findings.

### 2.2 Transaction Cost Economics Applications In Construction Industry

The application of TCE theory in the construction industry is expected to improve the project performance as it facilitates better contractual procedures, encourage long term strategic methods of procurement, improve cost estimation and the whole procurement process. This is because TCE allows evaluation of hidden costs, and the transaction cost analysis could develop formalized standards and strategies through better contracts and cost estimation to limit risks and issues which ultimately reduces transaction costs (Dudkin & Välilä, 2006; Ho & Tsui, 2009; Soliño & Gago de Santos, 2010; Rajeh et al., 2013).

The theoretical research background on previous applications of TCE in Construction Industry delineated that TCE in Construction Industry is mostly associated with project management, transaction costs, cost- benefit analysis, risk management, decision making, and others as depicted in the following table.

**Table 1** Previous TCE Research in Construction Industry

| Research | Approach | Technique | Analysis |
|---|---|---|---|
| Transaction Costs and Housing Affordability in Asia (Cruz, 2008) | Quantitative | Document Screening | Content Analysis |
| Resilience Through Transaction Cost Economic Evaluation: Recognizing The Cost-Effectiveness of Sustainable Development (Whittington & Young, 2013) | Quantitative | Experiment | Experimental Analysis |
| Determining The Magnitude of Transaction Costs in Construction Procurement Systems: An Explanatory Study (Rajeh et al., 2013) | Delphi Method | Pilot Questionnaire and Semi-Structured Questionnaire | Structured Data Analysis |
| Transaction Costs Incurred by Construction Owners (Li et al., 2014) | Quantitative | Questionnaire | Statistical Analysis |
| Determinants of Transaction Costs in Construction Projects (Li et al., 2015) | Qualitative | Document Analysis | Content Analysis |
| Challenges in Delivering Green Building Projects: Unearthing The Transaction Costs (Qian et al., 2015) | Qualitative | Semi-Structured Interview | Content Analysis |
| Estimating Transaction Costs in The New Zealand Construction Procurement (Rajeh et al., 2015) | Mixed Method | Survey Questionnaire and Document Analysis | Descriptive Statistical Analysis and Content Analysis |
| Total Public-Private Partnership: Transaction Costs of Tendering (Thomassen et al., 2016) | Qualitative | Semi-Structured Interview | Content Analysis |
| Ideal Construction Procurement System based on Transaction Cost Approach (Ismail et al., 2018) | Mixed Method | Survey Questionnaire and Semi-Structured Interview | Structured Data Analysis |
| Influence of Cooperative Period of Municipal PPPs on Transaction Cost – A Case Study (Liu et al., 2020) | Qualitative | Case Study | Content Analysis |
| Assessment of Transaction Costs for Construction Projects (Emad et al., 2021) | Mixed Method | Survey Questionnaire and Semi-Structured Interview | Structured Data Analysis |

| Factors Influencing Transaction Costs of Prefabricated Housing Projects in China: Developers' Perspective (Wu et al., 2022) | Mixed Method | Survey Questionnaire and Semi-Structured Interview | Logistic Regression Analysis and Correlation Analysis |
|---|---|---|---|
| Dissecting The Project Anatomy: Understanding The Cost of Managing Construction Projects (Haaskjold et al., 2023) | Qualitative | Document Analysis | Content Analysis |

## 2.3 Benefits of Transaction Cost Economics Applications in Construction Industry

Transaction Cost Economics is seen beneficial to be practiced for construction industry as the theory has been successfully applied by previous research. According to Nozeman (2010), transaction costs increase costs of goods and services and knowledge about transaction costs is important to produce optimal cost efficiency.

Previously, a research by Cho (2011) applied transaction cost framework for housing redevelopment process in Korea and able to reveal various identifiable transactions and cost-incurring hazards that originate from uncertainty as transaction cost framework's primary concern is specified on process efficiency. The successful application is demonstrated in Alexander (1992, 2001a, 2001b, 2001c) which pioneered the application of the transaction cost framework to land use planning and control and property development. Buitelaar (2004) further applied the theory in analyzing the land development process in the Netherlands through the lens of transaction cost economics and Mccan et al (2005) evaluated environmental policies using transaction cost measurement. These research has managed to successfully demonstrated transaction cost approach's usefulness for the analysis of cross-public and public institutions as they are operationalized through addressing a series of activities: the identification of transactions and the related costs, the assessment of efficiency of extand governance structures to minimize on transaction costs and the recommendation of alternative forms of governance to replace the inefficient governance mechanisms (Cho, 2011).

Another research by Qian, Chan and Khalid (2015) unearthed the transaction costs due to the extra new activities in delivering green building and also to explore the potential of reducing them. The research found that transaction costs in comparison with actual construction costs are relatively obscure and how they are incurred in each stage of development is not well-understood. A better understanding of the nature and structure of transaction costs is necessary and that is why the research follows the well-established RIBA Outline Plan of Work to establish the transaction's stages and to study the transaction costs involved.

## 2.4 Limitations of Transaction Cost Economics Applications in Construction Industry

There is no theory that could claim as purely beneficial and has no limitations. There are some challenges faced by previous TCE studies and research. The first challenge is the contradictions in defining "transaction costs" (Farajian, 2010). The term "transaction cost" is not consistently defined in the construction industry because the concept of transaction cost is not completely accepted by all players in construction projects. Therefore, it is not clear whether transaction costs can be reduced, mainly because they are not defined systematically and consistently (Li et al., 2014).

The second challenge for TCE study is highlighted by Williamson, who introduced

the concept of TCE theory back in 1981, who concluded that measurement of transaction costs constitutes challenging difficulties (Williamson, 1996). This may contribute to the reason on why TCE is not widely applied in various industries including construction industry. According to Allen (2006), the theory would be more valuable if transaction costs could be measured with reasonable accuracy. The lack of standardized transaction costs definition is definitely a drawback and limitation that failed many attempts of TCE quantification in different research fields (Serigati & Azevedo, 2016). As an example, the economic profession has not been able to incorporate transaction costs in their analysis due to inconsistent definitions and frameworks, as well as difficulties in measurement and quantification (McCann et al., 2005).

These two limitations are well proven during the pilot study and data collection stage for this research, therefore meticulous strategies are indeed crucial to mitigate TCE's limitations and to ensure successful TCE applications in Construction Industry and Housing Development.

### 2.5 Strategies for Transaction Cost Economics Applications in Housing Development

Thus, TCE adoptions in Construction Industry and Housing Development requires adjustments to suit its special characteristics in addition to mitigate TCE's limitations and challenges. The strategies for TCE application are outlined in the table below as per executed by previous successful research.

**Table 2** Limitations of TCE in Housing Development and Strategies for Mitigation

| Limitations of TCE | Strategies for Mitigation | Source |
|---|---|---|
| Inconsistent TCE definition | A standard platform of measurement should be established such as RIBA Plan of Work to ensure consistency in activities listed in the pre-contract and post-contract of housing development | Qian et al., 2015<br>Toh et al., 2019<br>Toh et al., 2022 |
| Difficulties in TCE measurement and quantification | Quantification is done in percentage form by utilizing time spent by professionals in conducting the transaction activities as surrogate of cost due to possibly higher feasibility and accuracy | Rajeh et al., 2015<br>Thomassen et al., 2016<br>Ismail et al., 2018 |

## CONCLUSION

Findings from this study will be able to establish mitigating strategies for efficient TCE adoption in Construction Industry generally and in Housing Development specifically. The strategies will be able to suggest practical approaches for future TCE application in Construction Industry and Housing Development particularly to mitigate TCE limitations. TCE application strategy should be based on the RIBA Plan of Work template for a standardization of activities at pre and post contract in housing development to mitigate the limitation of inconsistent TCE definition and activities. Besides that, TCE application strategy is recommended to adopt percentage form as surrogate cost for higher feasibility and accuracy to mitigate the limitation of difficulties in TCE measurement and quantification. This paper also managed to suggest the suitable research methodology such as the research approach, research technique and research analysis for future research on TCE in Construction Industry.

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# THE CONTRACTUAL CHALLENGES AND STRATEGIES IN BUILDING INFORMATION MODELLING

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## ABSTRACT

The advanced integration process in BIM creates numbers of contractual challenges that lead to legal uncertainty and contractual disputes that hamper the efficiency of the BIM contract administration. The contractual requirements remain open to address the interoperability of BIM. This paper presents a preliminary investigation on the challenges and strategies to overcome BIM contractual issues. The study adopts qualitative approach and draws data from nine semi-structured interviews with the selected BIM personnel that possess knowledge and experience in handling contractual matters in BIM-based projects. Content analysis reveals four BIM contractual challenges namely: lack of contractual framework to regulate the use of BIM; lack of clarity on the intellectual property ownership of BIM model; unclear BIM roles and responsibilities of the project personnel; and incompatibility of procurement methods with BIM. The study further proposed four strategies to overcome the BIM contractual challenges identified namely: development of a BIM-based standard form of contract; establish clear license authorising to maintain copyright ownership; introduce professional liability insurance; and call for early contractor involvement for a collaborative procurement. This preliminary study hopes to provide a start to the development of an improved certainties in the BIM contractual administration practice in Malaysia.

*Keywords : Building information modelling, Legal BIM, Contractual challenges, Contractual strategies*

## INTRODUCTION

The first government project using BIM in Malaysia was National Cancer Institute (NCI) (Latiffi et al., 2015) have shown a positive track which reduced time to complete the project which from the benefits of BIM implementation (Rahim et al., 2021). The advantages of innovations such as BIM can only become viable and realizable if their contractual framework are clear and implementable (Olatunji, 2011). However, existing contractual framework within Architectural, Engineering, and Construction (AEC) industries are apparently biased to

fragmented conventions which is a major deterrent to the rapid adoption of BIM.

The rate of implementation of BIM has not yet kept pace with the benefits. Lots of studies have aimed to promote BIM in the building sector, but few have examined contractual constraints (Assaad et al., 2020).

Higher integration process in BIM creates more challenges to the project implementation. Alwee et al. (2021) mentioned due to the multi-party involvements, the contractual challenges in BIM adoption are very much related to unclear project roles and responsibilities, copyright, and insurance coverage. However, the construction practitioners are unaware the contractual challenge during the implementation of BIM at the project level or organization level (Criminale & Langar, 2017).

This article addresses contractual challenges to address the issues. Defining the challenges in every construction project crucial for the successful of the project and for the construction contract in particular (Dao & Chen, 2021). Hence, it is necessary to explore the actual contractual difficulties and feasible remedies that could accelerate its implementation in the Malaysian construction industry.

## RESEARCH METHODOLOGY

The research approach in this study is qualitative approach by using in-depth semi-structured interview as the instrument. The target respondents are from BIM practitioners who involved in BIM and has experienced in BIM contractual management. The interview session conducted via online conferencing tool. The total of nine interviewees have profile such as Director, Chief Marketing Officer and Quantity Surveyor, Service Management Department Manager, Contract Executive, Contracts and Commercial Manager, BIM Manage, Construction Contract Administrator, BIM Coordinator, Project Manager, Contract Manager and Executive Director. After all the data has been collected, the data then analysed using content analysis method. In the operationalization of the content analysis, there are three phases of include preparation phase, organizing phase and reporting phase.

## RESULT AND DISCUSSION: CONTRACTUAL CHALLENGES OF BIM IN THE MALAYSIAN CONSTRUCTION INDUSTRY

Table 1 shows that all respondents agreed incompatibility of procurement method is contractual challenges of BIM in Malaysian construction industry. This is consistent with Sebastian (2011) that design-bid-build procurement system limits full potential of BIM. 8 out of 9 (89%) respondents believed that contractual challenges of BIM in the Malaysian construction industry stem from a lack of contractual framework to regulate the use of BIM in construction project. Next, 6 out of 9 (67%) respondents agreed that contractual challenges of BIM in Malaysian construction industry is lack of clarity on the IP ownership of BIM model and 2 respondents (22%) agreed that unclear roles and responsibilities of project personnel in the use of BIM.

### Lack of Contractual Framework to Regulate the Use of BIM in Construction Project

The findings shows that there is a lack of contractual framework to regulate the use of BIM in construction project. R1, R7, and R9 agreed that BIM is still new to the industry and has low acceptance, especially in Malaysia. The government has yet to establish a BIM framework to mandate the industry to follow it. Thus, construction practitioners utilise different frameworks. The data supports Kent and Becerik-Gerber (2010) findings that BIM adoption as a collaborative framework is hindered by a lack of BIM contract issues and documents. Lack of BIM contract agreements makes practise ambiguous and reduces effort to identify participant roles.

R2, R4, R5, R6, and R8 also said that lack of involvement of BIM into contract document. R5 and R8 employ supplemental documents to implement BIM in their companies. R8 noted that most companies will add clauses and supplements to their contracts, and there is no BIM standard document.

**Table 6    Contractual challenges of BIM in the Malaysian construction industry**

| Challenges | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Lack of contractual framework to regulate the use of BIM in construction project | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 8 |
| Lack of clarity on the intellectual property ownership of BIM model | ✓ | ✓ | ✓ | ✓ | | ✓ | | | ✓ | 6 |
| Unclear roles and responsibilities of project personnel in the use of BIM | | | | | ✓ | | | ✓ | | 2 |
| Incompatibility of procurement method with BIM | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 9 |

R4 believed that BIM is only used to develop more accurate 2D documents that are not shared. He said the problem they constantly have is that architect and engineer issue their own drawings, and then they realise it not the same drawing. Most designers were unfamiliar with the BIM components that make up a contract record (Pandey et al., 2016). Without the BIM model in the contract, there are few concerns arise such as collaboration, clarity, and risk allocation.

However, R3 does not see the lack of contractual framework to regulate the use of BIM in construction project as a contractual challenge to the implementation of BIM. He believed that there are numerous numbers of references available such as British Standard or international standard, and he does not consider that lack of documentation is a reason that justified the low implementation of BIM in Malaysia.

**Lack of Clarity on the IP Ownership of BIM Model**

6 respondents agreed there is a lack of clarity on the IP ownership of BIM model. R1, R2, R4, and R6 argued that Malaysia lacks a clear copyright law to safeguard BIM data ownership. Data collected support Azhar et al. (2012) claim that BIM data ownership is not protected by copyright laws. Kent and Becerik-Gerber (2010) agreed that a lack of clarity on BIM data ownership and the need to safeguard BIM through legal legislation and copyright laws are contractual challenges in BIM deployment. Thus, BIM implementation

after transfer of ownership or authority to appropriate it becomes a challenge.

R2 noted that most projects have conventional contractual arrangements. The architect will create the schematic drawings, but as the design develops, more components and information will be added to the building. BIM models may collaborate with civil and structural engineers, mechanical and electrical engineers, landscape architects, façade designers, and quantity surveyors. Hence, because the outcome is co-created by many parties, BIM model (IP) ownership will become a crucial issue if it is unclear.

R4 and R9 also thought BIM joint activity could lead to accidental IP infringement. R4 added that BIM model IP ownership in Malaysia is not protected, thus there is a possibility of unintended infringement. Sharing the BIM model makes BIM everything. According to R4, some clients may transfer their past design to new projects, and the designer will adapt it to suit their own design. This raises data infringement. According to Crennan and Prehn (2013), if any design elements are repeated in future projects, copyright conflicts may arise because all project stakeholders can share project information and contribute specifics to the project model.

However, R5, R7, and R8 argued there is no contractual challenge of BIM on the lack of clarity of IP ownership of BIM model. R5 and R8 claimed that all parties in their companies must sign a non-disclosure agreement (NDA). With

NDA, they can only share information for internal use with end users or clients' consent. They can be sued if they expose the 3D model and drawings to outsiders. Thus, this safeguards the BIM model or drawings from outsiders.

R7 further stated that his organization stores models, drawings, and documents in the common data environment (CDE) which CDE can clearly organize ISO-compliant filling. CDE transparency lets them know who is working, sharing, publishing, or archiving each folder. They can grant or deny folder access to a designated person and it is how they restrict model ownership to prevent misuse. Thus, they do not believe they face BIM's contractual difficulty of lack of clarity of IP ownership of BIM model.

## Unclear Roles and Responsibilities of Project Personnel in the Use of BIM

2 respondents agreed that unclear roles and responsibilities of project personnel in the use of BIM hinder BIM implementation. R5 stated that because of this type of challenge, it is difficult for them to determine each other's roles and responsibilities. He said that supplemental clauses may not clearly explain all duties and responsibilities. BIM roles and responsibilities information is sometimes vague and does not adequately cover the various scales of enterprises, which affects their responsibility distribution (Kouider et al., 2019).

R8 also noted that the organisation wants to cut costs, therefore they only send one or two employees to BIM consultant training and plan to teach the rest in-house. Not everyone can teach and share knowledge, which makes roles and responsibilities ambiguous. Kouider et al. (2019) highlighted that there is limited documented guidance on the new roles of BIM manager and Information Manager in BIM technology. Instead, they have always been determined by the hiring organisation, which is limited by its size and expertise. Due to overlapping roles and rights and obligations, leads to inefficiencies in the construction industry.

Surprisingly, 78% of the respondents do not agree that there is unclear roles and responsibilities of project personnel in the use of BIM. R2, R3, R4 and R9 opined that they will actually have BIM execution plan (BEP) prior to construction projects commence. R2, R3, R4, and R9 agreed that they will have a BIM execution plan (BEP) before construction begins. The BEP clearly outlines project personnel's BIM roles and obligations, and construction practitioners must follow it because they signed and agreed to it. Thus, BEP clearly defines roles and responsibilities of project personnel of BIM and construction practitioners can avoid liability.

R1, R4, and R7 mentioned that the client will appoint a BIM consultant or BIM manager in a project team. The BIM consultant will ensure the roles and responsibilities of project personnel in the use of BIM are clearly stated in BIM execution plan. R6 indicated that there is a dedicated department for BIM, as Virtual Design Construction (VDC) in his company which responsible for supporting department BIM related matters, dedicated managers to manage people in charge for architectural model, civil and structural model and mechanical and electrical model. Therefore, they opined that no issue for the roles and responsibilities of project personnel in the use of BIM.

## Incompatibility of Procurement Method with BIM

All of the respondents agreed that incompatibility of procurement method with BIM is the contractual challenge of BIM in the Malaysian construction industry. R1, R2, R3, R7 and R9 stated that BIM model is no longer produced by single entity in a collaborative procurement, and traditional procurement is more to single entity which is client is the main person to engage people separately. A study by Sebastian (2011) has shown traditional procurement system adoption

limits full potential of BIM due to conventional procurement methos, actors are only involved for a specific project phase, have specific roles, limited liabilities and responsibilities are limited, and no tangible incentives for integrated collaboration.

Furthermore, R1, R3, R4, R5, R7 and R8 mentioned that incompatibility of procurement method with BIM is more time is needed at project start to establish the object structure and data modelling in the traditional procurement method. R7 added in traditional procurement method, the client will assign team separately and longer preparation time to define the project goal and parties' responsibilities. Sebastian (2011) supports such opinion that engaging traditional procurement in implementation of BIM, more preparation time was required to define the project goals and integrated working process and develop a semi-formal contract that spelt the responsibilities of project participants.

Additionally, R2, R5, R6, R7 and R8 have same opinion in which in traditional procurement method, contractor will not involve in early stage but after the tender stage which leads to the issues in coordination or understanding the design. The lack of early involvement of contractor from traditional procurement system (Song et al., 2009) will hinder the utilization of BIM model Eastman et al. (2011).

## RESULT AND DISCUSSION: STRATEGIES TO OVERCOME THE CONTRACTUAL CHALLENGES OF BIM

Table 7 illustrates the strategies to overcome the contractual challenges of BIM in the Malaysian construction industry. 5 respondents (56%) agreed that BIM-based standard form of construction contract should be developed to overcome lack of contractual framework to regulate the use of BIM in construction project. Besides, 5 respondents (56%) proposed copyright ownership should be clarified in the contract and 4 respondents (44%) agreed that licensing authorizing should

be established for lack of clarity on the IP ownership of BIM model challenge.

In addition, 2 respondents (22%) agreed that appropriate design liability should be incorporated in BIM contract and professional liability insurance should be introduced for unclear roles and responsibilities of project personnel in the use of BIM. Lastly, 9 respondents (100%) agreed that adoption of relational project delivery system is required and early involvement of contractor is important to overcome incompatibility of procurement method with BIM.

## The Development BIM-Based Standard Form of Contract

The findings shows that there is a need to develop a BIM-based standard form of construction contract as a strategy to solve the lack of contractual framework to regulate the use of BIM in construction project. R4, R6, R7, R8 and R9 have the agreed that a viable BIM-based construction standard contract document is required to clearly express the associated with BIM for effective BIM implementation.

However, R1, R2, R3 and R5 disagree which they think there is needless to develop a BIM-based standard form of construction contract. R1 opined that it is crucial for construction practitioners to follow the standards. R2 stated that construction practitioners still stuck with standard form of contract PAM 2006 instead of PAM 2018 which shows reluctant to migrate and possible to happen to a new BIM-based standard form of construction contract. R3 stated a lot of time and cost for development of a BIM-based standard. He finds very low implementation rate in the industry for implementation of standard form of contract PAM 2018, or MYSMM. There is a poor feasibility and difficulty in implementation. R5 opined that administration of new standard form of contract will be difficult. Thus, maintaining the use PAM contract and add the BIM clause as supplementary is better.
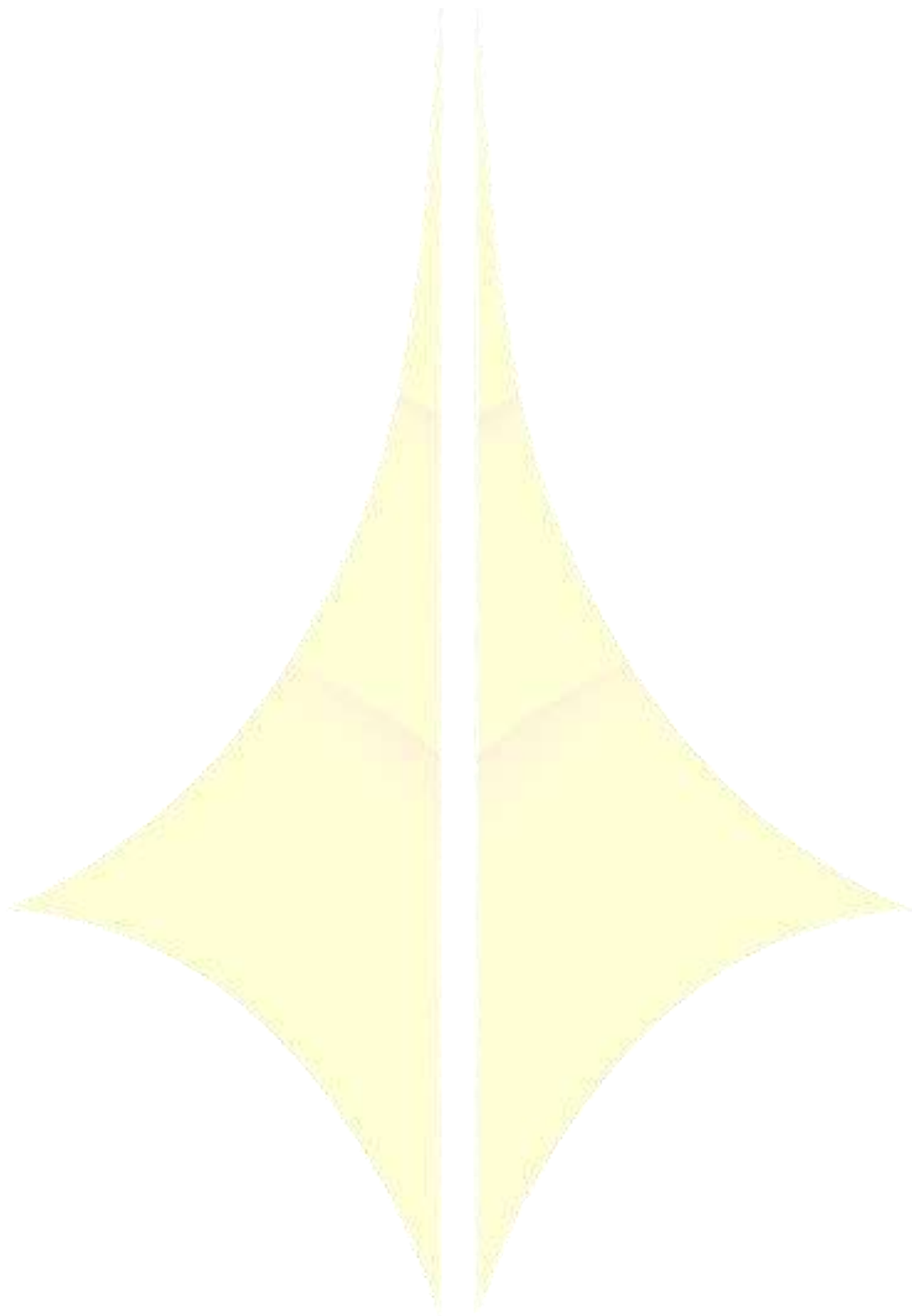
**Table 7 Strategies to overcome the contractual challenges of BIM in the Malaysian construction industry**

| Strategies | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Challenge 1: Lack of contractual framework to regulate the use of BIM in construction project | | | | | | | | | | |
| BIM-based standard form of construction contract should be developed | | | | ✓ | | ✓ | ✓ | ✓ | ✓ | 5 |
| Challenge 2: Lack of clarity on the intellectual property ownership of BIM model | | | | | | | | | | |
| Copyright ownership should be clarified in the contract | ✓ | ✓ | | ✓ | | ✓ | | | ✓ | 5 |
| Licensing authorizing | ✓ | | | ✓ | | ✓ | | | ✓ | 4 |
| Challenge 3: Unclear roles and responsibilities of project personnel in the use of BIM | | | | | | | | | | |
| Appropriate design liability should be incorporated in BIM contract | | | | | ✓ | | | ✓ | | 2 |
| Professional Liability Insurance | | | | | ✓ | | | ✓ | | 2 |
| Challenge 4: Incompatibility of procurement method with BIM | | | | | | | | | | |
| Adoption of relational project delivery system is required | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 9 |
| Early involvement of contractor | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 9 |

## Copyright Ownership Should Be Clarified in the Contract

Findings from 5 respondents agreed that copyright ownership should be clarified in the contract solve the lack of clarity on the IP ownership of BIM model. R1, R2, R4, R6, and R9 agreed that clear guideline in a contract document stating the IP ownership of BIM model is important to procure the security of data, such as drawings and specification since the data used in BIM is assessed by various parties.

However, R3 in contrast opined that sufficient education to the construction industry practitioners is essential, instead of clarifying copyright ownership in the contract and they must know in common sense that how copyright should be done. Therefore, it is not important for the ownership to be stated in the contract term when the construction industry practitioners are aware on the IP ownership which the issue of copyright ownership or data infringement can be avoided.

## Licensing Authorising

R1, R4, R6 and R9 agreed that licensing authorizing should be establish to avoid copyright ownership issue. Respondent R4 mentioned that license authorizing is a proper way to limit access of the other parties once established. This can avoid the issue of data infringement of IP right of another party when using the model of that party. Hsu et al. (2015) supports to avoid issues of copyright infringement, the license would grant permission to all participants in response to the development of freeware and mass collaboration. However, R2 and R3 opined that licensing authorizing is impractical due to highly collaborative nature of BIM and contribution from various project participants and it is not effective in solving the issue of data infringement of IP right.

## Appropriate Design Liability to be Incorporated in the BIM Contract

R5 and R8 agreed that appropriate design liability should be incorporated in BIM contract. The contract documents should specify whether incorporated submittals, such as vendor-supplied objects, are included in the designer's deliverables and who is accountable for their incorporation and coordination. The project design must be expressed clearly. Almarri et al. (2019) indicated that contract clauses or provisions must be established to effectively resolve the contractual challenges of responsibility and liability, and properly allocate the risks. The contract must have provisions to cover the liability for modelling errors.

## Professional Liability Insurance

R5 and R8 agreed that professional liability insurance should be included in BIM implementation regardless of whether it is BIM or non-BIM project which professional indemnity insurance is a must. The construction players will read the professional indemnity insurance and understand the requirements, and BIM being part of it, therefore this insurance

already covered. This is consistent with the Clause 5.7 in ConsensusDocs (2008) requiring each party to obtain and maintain a minimum value of insurance coverage to cover their contributions or intender contributions, to include this requirement in any contracts with other project participants, and to provide the other with a certificate of insurance demonstrating compliance with the requirements.

## The Adoption of Relational Project Delivery System

To overcome the incompatibility of procurement method with BIM, relational project delivery system is a need. All of the respondents agreed that Integrated Project Delivery (IPD) is the most suitable procurement method to suit with BIM project. Respondents R1, R2, R3, R4, R5 and R8 agreed that for BIM based project, it is crucial for project participants integrate everything together so everyone clear with the project and collaborate together. IPD is a contract system suitable with BIM-based project where project participants mutually conclude a contract to agree to collaborate extremely closely, share profits and losses within a certain framework, and foster collaboration through common decision-making bodies.

This is supported by Smith (2013) in IPD procurement method, BIM works efficiently because it establishes common goals for all project stakeholders, as opposed to the traditional approach, which prioritises project participants' personal goals. Thus, combining IPD procurement with BIM generates a condition of collaboration that has several benefits throughout the project, including enhanced efficiency, fewer errors, ease of exploring alternative approaches, and a continuous flow of information (Singh, 2021).

Respondents R7 and R8 also agreed that BIM-based IPD is an innovative procurement in construction which facilitates for effective BIM adoption. However, they stated this procurement method might bring pros and cons on each

process. Different procurement caters with different project. R8 added that different types of projects need different BIM strategies. He mentioned that IPD is more suitable for commercial or industrial project because need of specialists as not all contractors have the ability and understand the nature of project. Therefore, the specialist contractor could give their opinion in terms of the buildability.

## Early Involvement of Contractor

The findings are clearly proved that early involvement of contractor is crucial for smooth and effective BIM implementation. All of the respondents agreed that BIM-based construction project is highly collaborative in nature, and they could collaborate more efficiently if the contractor involve earlier. R4 mentioned it is the best way, but it comes with risk. It is a good procurement method to have the contractor involved early, but the client needs contractor that they trust. For instance, in-house contractor will give advice on constructability honestly to their developer or client.

Furthermore, R6 mentioned once the construction team coordinate before the superstructure or the substructure is built it can minimize clashing and double handling, and thus prevent the issue of incompatibility with BIM. Besides that, R9 suggested early contractor involvement at start of BIM coordination allow them submit their shop drawings. For instance, in the process to coordinate the underground services, the contractor should know to locate their tower crane so that the location does not clashes with other services, and thus enables them to collaborate more efficiently.

The finding supported by Bodea and Purnuş (2018) which the contractor should be involved earlier in the adopted procurement approach. To maximize the successful implementation of BIM, construction procurement that facilitates early involvement of all key stakeholders in the design stage is preferable. Since

BIM is designed to facilitate a more integrated team approach, a procurement system must focus on how to secure early enough BIM model contributions from the main contractor and specialist contractor without incurring delays or fragmenting the client's warranties.

## CONCLUSION

This study used a qualitative method and collected data from nine semi-structured interviews with selected BIM professionals with contractual experience in BIM-based projects. Data were analyzed using content analysis method. This research explored the contractual challenges of BIM in the Malaysian construction industry and proposed strategies to overcome them based on the perspectives of private sector construction practitioners. Thus, additional research on BIM's contractual challenges in public construction projects and its solutions should benefit this industry. Also, a difference between contractual challenges of BIM in Malaysian private and public construction projects may be discovered to better understand the contractual challenges experienced by various BIM practitioners.

This study intends to promote BIM adoption in the Malaysian construction industry. This research provides contractual challenges BIM practitioners face during the project procurement process. The right strategies are needed to remedy the fragmented and isolated construction contractual practices. The findings could help the Malaysian construction industry to innovate. From this research, the contractual challenges and proposed solutions guide BIM practitioners in project contractual administration, increasing BIM adoption and optimizing BIM use.

## ACKNOWLEDGEMENT

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# MANAGING POST DISRUPTION SUPPLY CHAIN RECOVERY

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## ABSTRACT

Post-disruption recovery of construction industry in Malaysia is typically slow compare to other sector. The issues related to post-disruption is lagging productivity development and increased economic weight of the supply chain. The general problem to be addressed in this research is the lack of enhanced construction supply chain management system in the post-disruption era while the specific problem is how the contractors implement an appropriate supply chain management system to meet fluctuating post-disruption demands. In this study, the identification of the supply chain management strategies post-disruption was carried out on the construction sector, through descriptive case studies research method. The case studies involved three real-life residential projects in Johor Bahru that were awarded in year 2019 and completed in year 2021 to year 2022. This study focusing on enhancing the supply chain management strategies followed until now, by compared the information gathered from these three studied cases to the pre-existing theory. The findings show that the post-disruption supply chain challenges of contractors is driven by the cost of construction material and availability of labour resources. In addition, contractors have relied on various strategies such as stockpiles material in advance, turned to alternative suppliers, considering options for specified materials to overcome supply-chain shortages and rising costs. It also indicates that efforts made by contractors in building new supplier network and strengthen relationship with fulfillment suppliers. By adapting effective supply chain management strategies to overcome the impact from post disruption, contractors will enhance their awareness for future disruptions that are certain to occur.

*Keywords : Supply Chain Management, Post-Disruption, Challenges, Strategies, Contractor*

## INTRODUCTION

The construction industry which plays a significant role in the nation's economic, societal, and political development (Donaldson, 2018), is a risky business with numerous risks and uncertainty along the process (Adhikari and Poudyal, 2020). Internal financial problems, working capital problems, lack of communication between supply chain partners, productivity inefficiencies, delivery reliability problems, or bulk materials quality problems which involve all of the entities in the typical construction supply chain like architects and engineers, main contractors, subcontractors, and material suppliers

could cause the entire supply chain disruption. (Benton and McHenry, 2010). In addition, the recent onset of deadly COVID-19 has reinforced the fact that world could face large scale disruptions due to pandemics in future (Donthu and Gustafsson, 2020).

Moving into 2023, construction industry in Malaysia has begun to recover after being negatively impacted by the COVID-19 pandemic (Department of Statistic Malaysia, 2023). However, compare with other economy sector, post-disruption recovery of construction industry is typically slow (Ministry of Human Resources, 2023). According to Zamani et al. (2021), the continuing to recover from the pandemic is hampered by craft labour shortages and unsteady building material manufacturing output.

As disruption related to labours and material is continuous, it causes for the housing price to keep rising (Abdul Latef et al., 2018). The sharp increase in Malaysia house prices from 203.50 Index in the third quarter of 2022 to 207.40 Index in the fourth quarter of 2022 has been one of the most remarkable result from implication of post-disruption of construction supply chain (Central Bank of Malaysia, 2023).

Larasati et al. (2021) noted that to compensate for the average increase in material and labour costs, main contractors have been increasing amounts of labour and material, consequently rising reliant on other stakeholders in the construction supply chain like suppliers and subcontractors. Therefore, the traditional approach to the control of the construction supply chain is not adequate any more, and a shift of methods for managing the supply chain is needed (Vrijhoef and Koskela, 2000).

It was found that lack of previous research has provided a related strategies regarding supply chain management that Malaysia contractors can execute to reduce the post-disruption impact on construction project. In this context, this study analyzes the impact from perspective of contractors on post-disruptions of supply chain in construction, determine the recovery challenges of contractors in rebuilding construction supply chains, and develop post-disruption supply chain management strategies through categorized pre-established studies. Specifically, this study assists contractors in adapting effective supply chain management strategies consequently reducing the vulnerabilities of supply chain post-disruptions.

## METHODOLOGY

### Case Study Research Method

From various types of design, researcher of this study believed that a case research design is the appropriate design for the research since a case study is a research approach that is used to generate an in-depth, multi-faceted understanding of a complex issue in its real-life context.

### Research Method and Data Collection

This research is based on case study of three residential housing projects in Johor Bahru Malaysia that facing price escalation and delay due to post-disruptions of supply chain. Three projects selected for case studies were double storey housing projects that originally planned starting in year 2019 and to be completed in year 2020 or 2021. Researcher obtained sources of case studies through documents and data collection, interviews, and direct observation. Table 1 show brief of case studies selected.the study.

### Population of The Study

To determine the recovery challenges of contractors in rebuilding construction supply chains, face-to-face or telephone interview was conducted with person in-charge of contractors that were involved in the sub-contract of the case studies. 5 group of contractors that representing various category and specialization in construction; grade G3 to G7, were selected as respondents of interview.

While construction projects resume operation post- pandemic, these contractors are continuing to operate but are having problem in materials and labours supply chain. Table 2 is the details of background information about the respondents from contractors involved in case studies.

## MAIN RESULTS

### *Analysis of Case Studies on Identified the Post-disruption Impact to Construction Supply Chain*

Projects fortnightly report and correspondences document related to project duration and cost were collected to get an overview about the impact of post-disruption to each project.

All three projects A, B, and C were facing the same post-disruption impact which is shortage of essential construction materials in the recovery from the pandemic. Due to pandemic which had resulted in a world wide supply chain disruption, supply sources were disconnected and production facilities were shut down creating a shortage at the supplier. Various construction materials that required for project resume was not reaching the construction site due to stop work of manufacturer from the origin sources, consequently facing the lack of building materials from factories abroad. The three projects faced further problems to serious supply disruption due to China's zero-COVID strategy during stage resume works post-disruption. Obstacle of global logistics due to import restrictions and the sealing of borders caused further disruption since selected brand of materials such as sanitary wares and ironmongeries were originally input from China. Suppliers expected to take at least six months or more to resolve the issue. However, the cases studied were behind schedule due to pandemic so were urge to complete the idling works and catch-up the schedule.

This has resulted in replacement of materials. Then, the three projects experienced a slight price increase in propose different brand but equivalent quality of materials for replacement of those materials that were pending delivery from China since the original material price were odered in a lower price. Further spend for replace the changed materials to the house units that were completed construction without additional claim.

Alike the material disruption, the workforce availability was impacted too. All three projects A, B, and C facing the same labor shortages problem since the global lockdowns were first imposed in response to the pandemic. The three projects were struggling in getting enough qualified skill workers when projects resume works since the existing workers were facing problem of expiry of the workers' permit and were then stuck at their home country. Those workers have not been allowed to reenter to Malaysia for working unless obtain valid workers' permit. To avoid further delay of contract, person in-charge of the three projects have to get workers from the other contractors by raising wages and consequently an added financial burden caused.

These additional cost that spent to resume works had badly impacted financial status of projects. Data collected showed that construction cost of Project A exceed RM 1.6 million compared to it's original project budget. Through comparative analysis of Project A, B, and C, all three projects were facing a delay of one year and additional cost caused by post-disruption supply chain issues. The final contract completion date of Project A was 25 October 2021. Project B was completed on 22 February 2022, and Project C was completed on 19 July 2022. Result of finding stated that supply chain post-disruption impacting project planning by delaying projects to complete on time.

To determine post-disruption price implication, three similar nature projects were selected for comparison of Project A, B, and C, Similar nature of project selected to compare with Project A is a 110 units double storey housing project (Project D)

with a budget of approximately RM 24.50 million. The project was originally planned for 20 months, starting 7 March 2022 until 6 November 2023. Similar nature of project selected to compare with Project B is a 125 units double storey housing project (Project E) with a budget of approximately RM 29.05 million, The project was originally planned for 19.5 months, starting 1 February 2023 until 15 September 2024; .and similar nature of project selected to compare with Project C is a 105 units double storey housing project (Project F) with a budget of approximately RM 18.48 million. The project was originally planned for 17 months, starting 15 November 2021 until 30 April 2023.

With reference to data collected, contract value based on rate per square feet of Project D, E, F were increased caused by additional cost spending on post-disruption of supply chain. The construction cost of Project D, E, F is higher than Project A, B, C. The additional cost is approximately 35%. However, the comparison result also showed that contractor get the project by reducing their profit since estimate profit of Project D, E, F are lower than Project A, B, C. Original contract of Project F is three months shorter tan Project C although the total housing units of Project F is more than Project C. According to person in-charge of Project F, a three months of application of Extension of Time (EOT) was submitted as they were facing acute shortage of skill workers and late delivery of building materials such as common bricks and PVC corner bead.

### Analysis of Case Studies on Identified the Challenges of Rebuilding Supply Chain Post-Disruption

As mentioned on analysis of post-disruption impact to construction supply chain, projects were facing problems in completion on time, resource availability in terms of material transportation lead time and extra cost in the post-pandemic period. As such, five different categories of contractors in CIDB grade G3 to G7 who involved in the sub-contract of the three studied cases were chosen as respondents of research to determine the post-disruption supply chain recovery challenges and management strategies of contractors in rebuilding construction supply chains. To understand the most significant recovery strategies for improvement, researcher review and categorize relevant previous studies in order to obtain practices of existing supply chain management strategies and researcher use these pre-established studies as a starting point to structure the interview questions for respondents to refer and determine. Table 2 is the details of background information about the respondents from contractors involved in case studies.

According to the table developed by the researcher (Table 3), it was found that Contractors biggest challenges for rebuilding the supply chain are inflation caused price hikes for materials and labour wages, building new supplier network, time-consuming material logistical issue, and skill labours shortages.

The top challenge contractors in this study identified in rebuilding supply chain is inflation. All five contractors mentioned that cost of some materials has fallen as enter the post-pandemic period, but the materials prices remain significantly higher than pre-pandemic period. All contractors reflected that their project cost is generally increase. They noted that substantiate cost had been spent by them in purchase materials and labours hiring since material cost fluctuation and rising of labour wages due to inflation of global supply chain post-disuption, then result in cost overrun of the project. All contractors foresee more cost will incurred in near future if wages and materials price keep rising. They said the worldwide energy and freight cost is keep increasing and that is driving the costs of construction materials up. According to Contractor A and Contractor B, as continue increasing of energy cost, prices of energy-intensive products like bricks, cement, and glazing material are

significant increases. Contractors also reflected that they are not optimistict to the implement measures that can ease the impact of rising building material costs since they cannot control such impediment that cause costs increase. Moreover, contractors mentioned their profit is tiny for successfully in bidding, the climbing costs and extra spending on the inflation costs causing them further reduce their interest.

The next challenge that contractors were facing when rebuilding supply chain post-disruption is building new supply chain networks. All contractors outline that they are in difficulty in developing multiple supplier relationships or to build a strong working relationship with new suppliers. A big issue for them is the flow of material supply post-pandemic. Contractor B and Contractor C pointed that some of their supply chain partners reduce their production after pandemic and Contractor A was facing problem of supplier stop operations permanently. Such situation presents contractors to purchase materials with others who have equivalent materials on hand but they start to see cost-increasing for those substitute materials. As decrease of sourcing option, other suppliers seek to increase their selling price. The five contractors responsed that they found the lack of alignment between them and new suppliers is difficult in benefit them in their business. Contractor A and Contractor C said they are still trying to enter a long-term relationship with new sourcing suppliers through negotiation.

Also, all of the contractors that participated this study said the time-consuming material logistical issue will make it harder for them to achieve their long-term planning on rebuilding the supply chain. According to Contractor B, Contractor D, and Contractor E, glazing, tiles and mechanical materials has long lead time right now. Contractor A further mentioned that the lead time of bricks is longer than their schedule planning. So, almost all projects they need to request extension of time to complete the projects. The five contractors said since they cannot avoid these delays, they are trying to find all posible solution but that caused additional financial issues on them.

Contractor A explained the scarcity of brick and corner bead they usually use in the project made them proposed alternative brand meanwhile waiting for their order but unfortunately other similar trade contractors also did the same action then causing a ramp-up in demand of alternative materials, result in the shortages and price hikes in alternative material. Contractor B and C said that the unavailability of alternative materials in the market is another pressure for them to respond to the delay of project and forced them to purchase and store some materials in advance. Contractor B purchased the raw material for glazing that can let them use for one year and Contractor C ordered sanitary ware to be used 15 months later but both contractors agreed that to allocate payment for purchase materials in advance is kind of financial impact weighs heavily on them.

The last challenges in rebuilding the supply chain that all five contractors stated is skilled labour shortages. All five contractors told that the shortage of skilled labours that has troublesome the construction industry post-pandemic shows no signs of lessening, subsequently make their projects take longer and cost more. Contractor A expect to hire more foreign workers. Contractor B, C, D, and E increased base pay rates more than pre-pandemic period to keep their workers. However, all contractors worried about getting new skill foreign workers when their existing skill foreign workers reach maximum age limit and máximum period of employment. Contractor C and D said they are now trying to apply 3 more years work permit for their foreign workers that reached the máximum limit of foreign workers employment; through recalibration program. All contractors are currently having difficulty finding experienced skill workers and a majority of them expect the difficulties to continue.

## Analysis of Case Studies on Identified the Post-disruption Supply Chain Management Strategies

Viewpoint surveyed the same five contractors to understand how contractors are adapting their strategies on the supply chain due to post-disruption implication. Three main questions were prepared for the five Contractors to answer. Table 4 summarized the answers of repondents.

Depending on company goals, contractors in this study adopted some strategies to mitigate the impact of post-disruptions to supply chain. Most of the contractors commented that they are trying to minimize the post-disruption impact on supply chain by diversify the suppliers. Contractor A, B, and E said they realized that relying on a single supplier for materials is risky. So, by diversifying suppliers, they can ensure that they have access to alternatives if one supplier is unavailable. Moreover, Contractor A stated that having alternative suppliers can help in mitigate future disruptions and provide help to fulfill shipment orders if existing supplier is temporarily disabled. Contractor A is now issue purchase order of bricks for whole project to three suppliers instead of single supplier. According to Contractor A, building long-term relationships with multiple suppliers is the focus of diversifying their suppliers. Contractor B further noted that maintain relationship with alternative suppliers in advance help to reduce the risk of using a supplier in an emergency that may accelerate order costs. However, as mentioned by all contractors in the interview, building new supplier network is kind of challenge to them since finding the suppliers that meet their criteria especially in term of product quality and cost is not easy. All five contractors of this study said expanding supplier base takes time to select new suppliers that work best for jobsite and project timelines.

Besides expanse and diverse suppliers, maintain strong relationship with existing fulfillment suppliers is also one of the strategies that all contractors in this study

implemented. Contractor C said that setting up deals with new suppliers sometimes involve initial cost like downpayment. All contractors agreed that they prefer establish long-term relationship with key suppliers because there is trust built between them and the key suppliers. Key suppliers understand their need and will always give their best offer to contractors. Contractors believed that the strong relationship with key suppliers help them in cost savings, in term of reduced issues with order availability, quality and delivery.

Also, all contractors in this study started to build backup Inventory. All contractors agreed that the pandemic highlighted a weak spot that they lacked clear insight into their materials supply chain. Contractor A said if they can get accurate read on their inventory, the idling time in searching for materials while waiting for new arrival of materials could be reduce. Contractor E said the establishment of backup inventory is important since supplier lead times become more unpredictable compare to pre-pandemic period. All 5 Contractors said they started to itemize materials should be stockpiled and decided to purchase these materials in advance as safety stock after they ensure the warehouse space and financial cash flow is in order. Beside purchase in advance for stockpile, Contractor A also consider to keep reusable materials as backup inventory. Contractor A kept reusable building materials such as used metal hoarding, scaffolding frame, and container in their store. These reusable materials were then help Contractor A in reducing project preliminary spend.

## CONCLUSION

This study attempts to assist contractors in identifying their capabilities of the supply chain and adapting effective supply chain management strategies to overcome the impact from post disruption meanwhile enhance their awareness for future disruptions that are certain to occur. It is impossible for contractors to completely avoid the impact of post-disruption to

supply chain. However, with knowing the challenges in rebuilding the construction supply chain, and proper response in building valuable supply chain management strategies to protect supply chain against future disruptions, loss could be limited to a great extent.

The research findings from case studies show similarity in impacts of post-disruption supply chain to contractors, challenges facing in rebuilding construction supply chains, and managerial strategies for mitigating post-disruption supply chain management. A comparative analysis of studied cases with similar nature cases provides a contractor perspective view of the post-disruption issues of supply chain. The finding show that the challenges in building supply chain recovery are inter-related to the post-disruption impacts. Three managerial strategies to mitigate post-disruption impacts and rebuilding challenges were discovered from the answers provided by the five contractors in this study.

To determine the most significant recovery strategies for improvement, researcher review and categorize relevant previous studies in order to obtain practices of existing supply chain management strategies. From the finding, contractors ideal strategies on improving post-disruption supply chain were similar as managerial strategies proposed by other researchers in previous studies. Researcher therefore develop this three strategies by including focus and consideration of the strategies.

The target benefician of this research is mainly contractor. Further research might explore the relatively topic by involved other construction stakeholders in research.

## ACKNOWLEDGEMENT

This study provided for researcher personal and professional growth. As first party of contractor, researcher had clearer pictures in solving problems related to supply chain in future. Hence, through data collection process, researcher built

stronger network connection with the participants of case studies consequently help researcher in strengthen professional relationship.

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# A REVIEW OF ADDRESSING PAYMENT DELAY IN GHANA

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## ABSTRACT

Payment problems have continually raised grave concerns in construction industries throughout the world. Several studies have suggested that payment is to be the lifeblood of the construction industry; however, the construction industry worldwide suffers from poor payment practices. Delay in payment is considered as one of the major issues in the construction industry. Various studies have shown that late payments or even worse, nonpayment could cause problems towards project performance. Issues regarding payment appears to compromise the cash flow of a contractor, which may result to failure in delivering the project. The existing research appears to focus on the reasons and the consequences of the payment problem, but very few studies proposed methods for eliminating the problem. Hence, this study focuses on investigating the status of construction payment issues. The review will be conducted via Systematic Literature Review (SLR). SLR was conducted on payment issues articles published in three databases (i.e., Web of Science, Science Direct and Scopus) from 2022 until 2012. The findings of the report reveal that the country's policy implementation procedure for payment delays has constantly depended on a litigation and negotiation on the part of both sides to reach an agreement. This strategy, however, may discourage targeted stakeholders in the construction industry from participating in the policy-making process, or a lack of benefit for the intended stakeholders. The proposed approach entails a framework to mitigate payment delay policy, wherein both the government and the intended stakeholders involved in sharing their perspectives and requirements. The paper presents a conceptual framework for policy implementation process for a successful payment policy in Ghanaian construction industry.

*Keywords: Delay, delay payment, construction, Policy, Implementation, Ghana.*

## INTRODUCTION

Every nation's growth is dependent on the construction industry. (Essilfie-Baiden 2020). The industry builds structures and infrastructure that are necessary for social and economic development, thereby contributing to economic growth (Low Shing Hou and Sui Pheng 2019). Economic development will result in an increase in disposable income, which will drive demand for more construction

projects. As a result, it is critical to ensure that the construction industry's economic expansion proceeds smoothly. Previous study demonstrates that there is a tight association between building and a country's national economy. (LS Pheng 2019). It has been suggested that the economic downturn has a significant impact on construction quality. Zaid Mohammed Hatemk et. al., (2022) discovered that the share of gross value added in construction varied significantly across countries in the same GDP per capita category, ranging from more than 2% to more than 10%. while in developing countries it was around 23%. Divergence among developing countries was also observed. The divergence trend was explained by the fact that most infrastructure in developing countries was government-financed, and thus was directly affected by various government-expenditure policies (Zaid Abdul-Ghani et. al, 2022). In Ghana, the construction sector is estimated to contribute approximately $12.8 billion Ghanaian cedis (GHS), or approximately $2.1 billion USD, to the country's gross domestic product (Nechifor *et al.*, 2022). Further, the AEI Bank report (2022) indicate that, approximately 12.49 billion GHS were recorded. In 2018, the economy gained 13.1 billion Ghanaian cedis in value. Construction contributes significantly to Ghana's GDP (AEI Bank, 2020).

**Contribution of the construction industry to GDP in Ghana from 2019 to 2023**
*(In million Ghanaian cedis)*
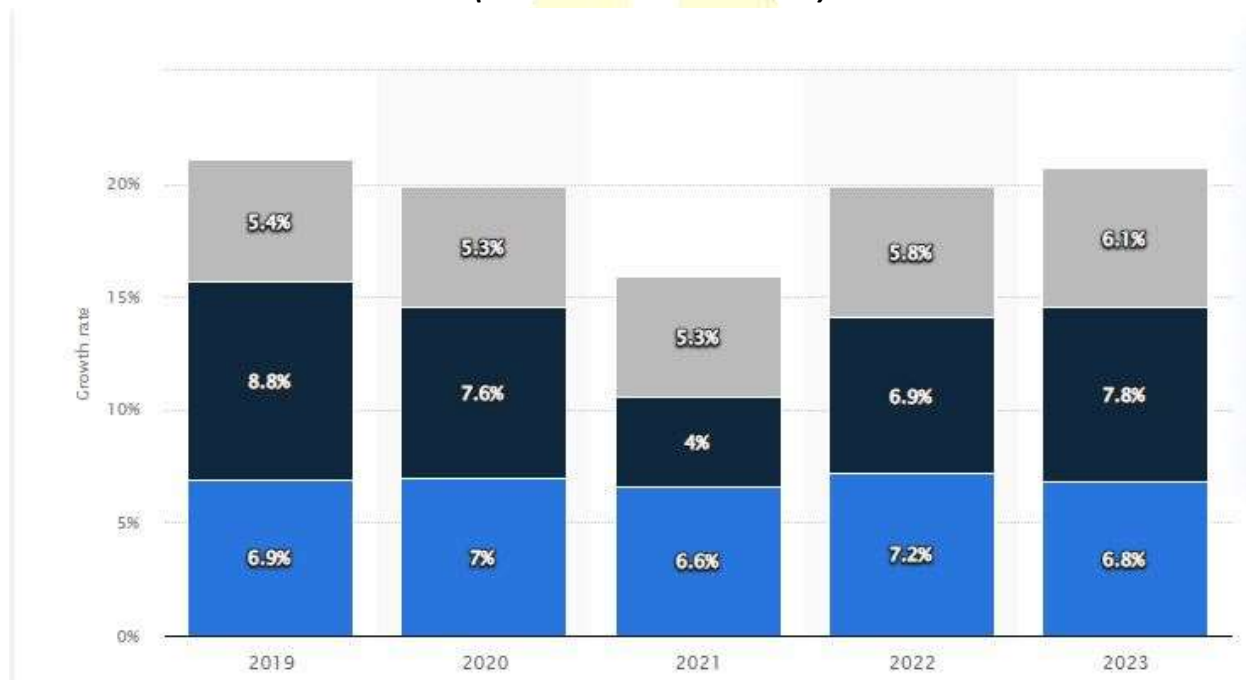


*Figure 2 Contribution of the construction industry to GDP in Ghana from 2019 to 2023 (In million Ghanaian cedis) source: Ghana statistical service, 2023.*

Despite this, Ghana's construction industry is failing to meet infrastructure demands adequately. Delays, shoddy workmanship, and cost overruns have all been commonplace in the industry over the years. Due to the significant capital expenditures and lengthy completion times associated with building projects. Payment is widely recognized as a vital component of the construction sector. However, the sector observes that payment default, particularly late and non-payment, remains a serious issue (Ali, 2006). Payment has a significant impact on project performance due to the involvement of numerous phases and multiple tiered parties. Payment concerns typically involve not just the contractor and

the client, but also the main contractor and subcontractors. Although many studies on payment have been conducted, research into the elements that contribute to payment default, particularly in commercial or public building projects, remains controversial. The research findings would pave the way for meaningful information to be delivered to stakeholders regarding payment delays.

## MAIN RESULTS

The evaluation process includes the selection of ten papers from journal articles. After identifying publications that incorporate payment delay, subcategories and the subject of publications are selected and subsequently analyzed using content analysis to evaluate research activities in this field. The study then summarizes how payment delays are incorporated with research aims. Seven of the ten publications interact with a payment delay. As a result, it is possible to deduce that payment delays cause major problems for the contractors' cash flow. As a result of late payments, several small construction companies have gone out of business. One of the most important aspects influencing project success is the practice of well-organized and timely payments in construction projects. Munaaim and Mohd (2006) Because construction projects usually take a long time to complete, huge sums of money must be spent, and credit payment terms are frequently utilized instead of payment upon delivery of goods, payment is increasingly important. (Wuni et al 2017). According to Samuel K Ansah (2011) Client late payments for services performed on projects are a major source of concern in Ghana's construction industry, substantially affecting contractors' cash flow and potentially putting them in a precarious financial situation. This study discovered the reasons that contribute to payment delays, such as poor financial management by employers, contract conflicts, and certification delays. To address the payment situation, contract terms for delayed payment must be enforced, costs

for past-due payments must be assessed, and a payment department must be established. (Ajayi1, 2016) concluded that Payment delays can diminish contractor efficiency, raise costs, and extend project schedules. Exaggerated cash flows, claim inaccuracies, poor financial health, and arguments over the value of labor were among the reasons for late payments, according to this study, which used the statistical program for social sciences (SPSS). Clients should look for co-investors to back up their financial commitment, and stakeholders should coordinate to avoid bottlenecks when selecting how much to pay contractors, according to the findings. Wuni et al. (2017) suggested that payment delays have a significant impact on the efficiency with which government projects in Ghana are completed and implemented. A case study sample survey was utilized in this study to assess and rate the primary causes and effects of payment delays. According to the data, eight out of ten reasons for payment delays were regarded significant, with the top five key reasons being certification delays, poor financial management, client withholding of payment, ambiguous contractual language, and interpersonal conflict between the parties. Among the 11 repercussions were project abandonment, cost overrun, completion delay, bankruptcy/liquidation, and time overrun. The report recommended that all parties establish acceptable payment schedules before the project began, as well as constant interaction and forewarning. (Haron & Arazmi, 2020) The practice of timely and effective payment in construction projects is greatly influenced by the practice of timely and effective payment in construction projects. Delays in payment to subcontractors by the contractor and client on construction projects are accepted as a major source of uncertainty in the Malaysian construction industry due to the potential for severe cash flow issues and financial hardship for construction companies. Based on the research findings that the major contractor's late payment is when the term "pay when paid" is used, the study

approach employed was a questionnaire survey analysis, while the client's late payment is one of the aspects that contribute to the problem. Contracts must contain particular methods for enforcing payment delays in order to improve the payment situation, such as adding usual contract language that includes collecting late penalties. (Bolton and colleagues, 2022) Late payments are a common issue in the construction industry in the United Kingdom. To investigate these issues, a research design and survey of 30 selected projects (355 payments) and 21 subcontractors were carried out. Because there was no significant association between payment delay and contract value, it was shown that subcontractors were more likely to experience longer payment delays in projects with greater payments. The study also indicated that the release of the second half of the retention posed an even greater challenge for subcontractors, with a significant fraction of the money being delayed for more than two months after the due date. The findings show that, while legal and contractual mechanisms have attempted to address the issue, it persists, and

subcontractors routinely violate them. Current developments that have the potential to remove payment delays include Project Bank Accounts, the central retained deposit scheme, and smart contracts. (Chadee et, al. 2023) Payment delays are a common occurrence in the construction industry due to unstable political circumstances and employers' tardy issue of variation orders. Payment delays are typically caused by an increase in the contractor's debt as well as delays in subcontractor and supplier payments. A risk response strategy was developed to assist small to medium contracting organizations in managing payment holdups both globally and locally. This research advances our understanding of construction management by educating policymakers and construction professionals about the consequences of delaying approved payments, their subsequent effects and causes, and a risk response technique that reduces the detrimental effects on contractors' funds. SPSS was used for the confirmatory factor analysis, and the structural equation model with the best fit was chosen.

**Consequences of the late payments in the Construction sector in 2018**
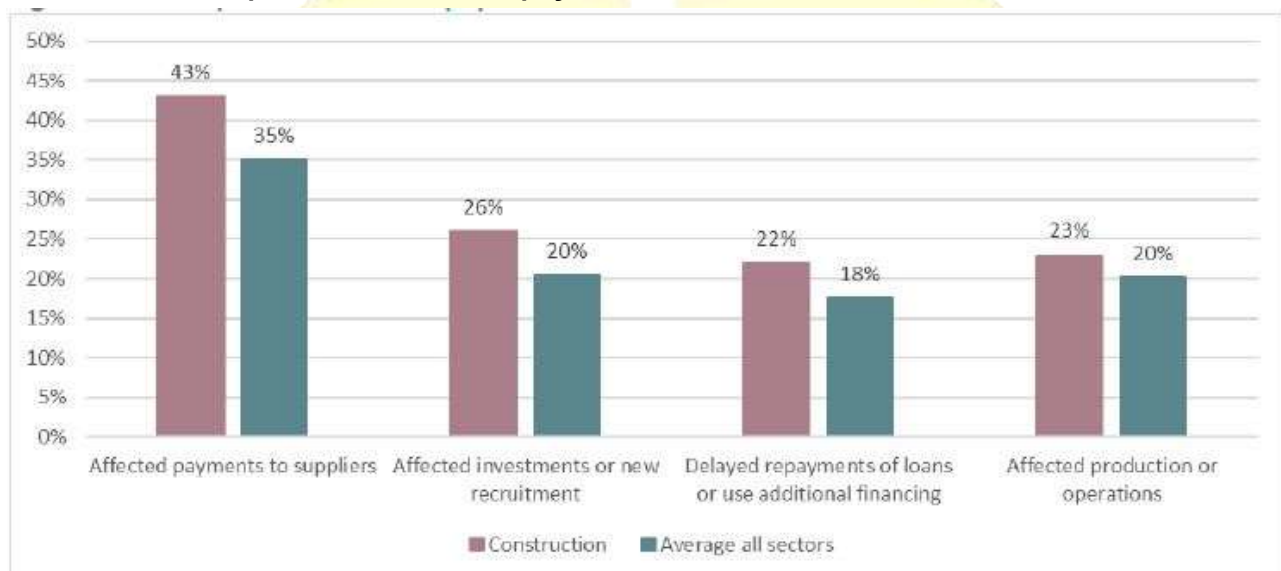


Source: Survey on the access to finance of enterprises (SAFE), Analytical Report 2019

Despite the approval and implementation of Directive EU 2011/7/EU, late payments continue to be a serious concern in the construction industry, impeding its long-

term development. Notably, late payment is a concern in all types of business relationships. Payment discipline in the public sector is frequently worse than in

the private sector. With EU construction growth expected to decelerate in the next years, late payments may become even more prevalent. Unfairly long payment periods and late payments are the result of both formal (contracts, payment processes, etc.) and informal (power imbalance in relationships) practices based on structural characteristics of the construction industry and its supply networks. As a result, dealing with late payments is a complex and diverse issue.

National policies and mechanisms addressing late payments in the construction sector are relatively new. They take the form of hard and soft restrictions that try to address late payments either upstream (before they occur) or downstream (after they occur). Furthermore, other legislative attempts target unreasonable extended payment terms. Based on the previous study work's analysis, this paper gives a collection of insights and lessons learned on the subject of unjust extended payment terms and late payments in the construction sector.

## CONCLUSIONS

Payment is a vital for construction companies to operate in the construction industry. Additionally, cash flow is becoming priority and important for them to sustain their business in short and long term. The impact can be seen if they do not receive the timely payment, then it leads to a negative impact to the company especially for those who handle numbers of projects at the same time. All the parties involved need to understand and try to avoid it from all factors that might contributing to the payment default. The suitable remedies also have to be introduced and implemented in order to solve the payment default issues in the current construction industry. The outcome of the research would be useful in paving an understanding and improved awareness on mitigating payment defaults among key participants involve in project development regardless private or public.

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# MULTISKILLING DIVERSIFICATION ON QUANTITY SURVEYORS FIRMS' PERFORMANCE IN ABUJA, NIGERIA

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## ABSTRACT

The increasing technological advancements, competition, and the dynamism of the construction firms has impacted on the roles of Quantity Surveying (QS) profession to diversify in allied profession. Hence, this study assessed the áreas of multiskilling diversification of QS to keep abreast of job turnover or sudden development in work environment. This study also examines the impact of multiskilling diversification on quantity surveyors firms' performance. The study adopted questionnaire survey as its research instrument, the target population are the registered quantity surveying firms in Abuja. A purposive sample of 80 quantity surveying firms were selected, out of which 60 responses were received, making 75% response rate. This study identified ten áreas of multiskilling diversification of QS and nine impacts of multiskilling diversification on QS firm's performance. The data collected were analyzed using Relative importance index (RII). The overall results implies a perfect significance, which indicates how much more the áreas of multiskilling are important for QS service diversification and how much more the impact of multiskilling diversification are on quantity surveyors firms' performance. The study concluded that the proliferation of knowledge in the construction sector coupled with the impact of technology in the workplace required QS firms to maintain service delivery within the ambit of business advances and development. Therefore, it was recommended that principal partners, operation managers and human resource managers should encourage QS to diversify in new marketable areas of optional competency to ensure business development and sustainability.

*Keywords : Construction industry, Firm's performance, Multikilling diversification, Quantity surveyors, Work environment.*

## 1.0 INTRODUCTION

The performance of construction firms are becoming complicated, dynamic, risky and uncertain (Yusuf et al., 2012). This have led to the development of innovative discipline (Pattanaik, 2012). As a result, the construction firms expects construction professionals to play diversified roles to meet contemporary requirements (Dada, 2017; Shayan et al., 2019). Being a key professional in the industry, a Quantity Surveyor (QS) is also expected to diversify his/her job to meet

the increasing expectations of the clients and the changing business environments (Ajanlekoko, 2012; Chamikara et al., 2020).

This new disciplines with great market opportunities have prompted professional quantity surveyors to diversify skills in allied discipline/profession different from the core skills of QS. In United Kingdom, some quantity surveying firms carry out insolvency and corporate restructuring, survey on hazardous materials and environmental audit (Abrams & Berge, 2010).

However, in Nigeria, the QS growth rate from the traditional core competence areas to new directions is steady and slow (Adamu et al., 2012). This view was corroborated by Akinola (2019) that quantity surveying practice is still in the mainstream areas in Nigeria. Accordingly, the threat for survival of QS on construction projects has made it imperative that certain strategic measures and innovations should be embarked upon by QS to keep abreast of developmental and professional changes by embracing multiskilling diversification strategy (Chamikara et al., 2020). This is in agreement with Dada & Jagboro, (2018) who indicated that multiskilling diversification strategy will expose quantity surveyors to new skills in order to compete with 21st century quantity surveyors. Therefore, this research seek to assess the áreas of multiskilling diversification of QS, and the impact of multiskilling diversification on quantity surveyors firms' performance.

Accordingly, this study first presents the findings from relevant literatures in relation to the QS profession and impacts of multiskilling diversification on QS firm's performance. Next, the research methodology followed by discussions through the findings. The final section summarizes the conclusion derived from the research findings and present recommendation.

## 1.1 Quantity Surveying Profession

Quantity surveying has always been considered as a dynamic profession and the skills sector has undergone various changes during its evolution over the past centuries (Ajanlekoko, 2012). Within its traditional sense, quantifying construction works has been considered as the main responsibility of the profession. In fact, in early 70s, this traditional role has been highlighted as the main function of the Quantity Surveyor by one of the profession's strong professional bodies, the Royal Institution of Chartered Surveyors (RICS). They highlighted the skills in "measurement" and "valuation" as the distinct competencies possessed by Quantity Surveyors, which entails the production of the Bill of Quantities and ended at the settlement of the final accounts. This highlights the distinguishably recognized "technical" role of the quantity surveyor of that era. Deviating from its traditional "technical" role, during mid-80's RICS have promoted the role of the Quantity Surveyor as "the Building Economist", "Cost Engineer", "Procurement consultant" and as a "Cost Consultant". These roles have attributed more of a "managerial" image to the quantity surveying profession. Accordingly, the quantity surveyor is expected to contribute throughout the entire lifespan of the construction project in a more managerial capacity (Shafie et al., 2014). Within its contemporary role, quantity surveyors undertake a spectrum of work ranging from providing investment appraisals to construction project management. Dada & Jagboro, (2018) considered the uniqueness of services offered by quantity surveying firms in the areas of financial probity in the execution of construction projects and noted that the major concern of the client is for the project to be completed to cost, quantity and schedule. However, it has been observed that it is not all executed projects that the clients are satisfied. This dissatisfaction brings to focus the quantity of services rendered by construction professionals. The above-mentioned paradigm shift in the role of the quantity surveyors was

triggered by various developments in the economic conditions, research and technological developments.

Thus, QS has been demanded to update their skills and competencies by taking new roles and responsibilities such as risk management as well as adopting advanced ICT including Building Information Modelling (BIM) for more accurate and automated cost estimation and planning from the outset of a construction project (Kim & Park, 2018; Shafie et al., 2014). Quantity Surveying is recently described as a mix of various professions such as contractual law, construction economics, and information management. This is in agreement with Yap et al. (2021) who described quantity surveying as the amalgamation of several other disciplines such as law, accountancy, business management, information management and construction technology within the unique context of the built to environment. RICS adopted ten core competncies of QS as follows; strategic planning, budgetary process, cost estimating, cost planning, procurement advice, contract documentation, tendering process, construction account management, construction change management and feasibility studies. Also, in United Kingdom, some quantity surveying firms carry out insolvency and corporate restructuring, survey on hazardous materials and environmental audit (Dada, 2017). Thus, Quantity surveyors are becoming increasingly involved in the project management, value engineering, risk and facilities management, life cycle costing among other new innovations.

### 1.2 Impacts of Skills Diversification on Quantity Surveyors Firms' Performance

Dada & Jagboro, (2012) noted that the need to respond to changes in professional environment due to pressure from within and allied construction professionals call for quantity surveyors to seek development in other areas than cost management. This view was also corroborated by McClement, (2012) that the need to globalized professional services warrants the exploration of new service market and optimised resources. Hence, the need for skills diversification as a concept.

Dada & Jagboro (2018) noted that the concept of skills diversification originated from USA and is being accepted beyond as alternative strategy due to emerging evidence of benefits. Several researchers have worked on skills diversification as a utilisation strategy (Dada, 2017; Dada & Jagboro, 2012; Dada & Jagboro, 2018; Hassan et al., 2011; Shafie et al., 2014; Yap et al., 2021). These authors summarised that skills diversification strategies enhanced organisational image, fastened job/service delivery, enhanced quality of service, increased opportunities for the development of process innovations and technology implementation, enhanced job coordination. It is also believed that skills diversification strategies contribute to economic development, increased profitability, and improved international competitiveness.

From the foregoing studies, risk management skills, project management skills, facility management skills, valuation skills, ICT skills, arbitration skills, development appraisal skills, property investment funding skills, research and development skills, and insurance skills were identified as the areas of multiskilling diversification of QS. While, enhanced organisational image, fastened job/service delivery, enhanced quality of service, increased opportunities for the development of process innovations and technology implementation, enhanced job coordination, contribution to economic development, increased profitability, and improved international competitiveness were identified as the impact of multiskilling diversification. Hence, it is the gap in identifying the áreas of multiskilling diversification of QS, and the most significant impact of multiskilling diversification on quantity surveyors firms'

performance that is the motivation of this study.

## 2.0 RESEARCH METHODOLOGY
### 2.1 Research Strategy

This study first adopted qualitative approach, which was based on a literature review and consisted of 10 areas of multiskilling diversification of QS and 9 impact of multiskilling diversification on quantity surveyors firms' performance, which have been examined by previous researchers, and were used to construct a structured questionnaire for the pilot study. A total of thirty construction professionals participated in the pilot study. The respondents suggested few changes regarding the wordings of the questions. The questions was then modified based on the feedback, before it was finally used at the data collection stage.

The questionnaire consist of three sections. Section A consist of respondents personal particulars such as; membership of QSRBN, years of experience, academic qualification and numbers of projects involved. In section B and C, respondents was asked to rank the áreas of multiskilling diversification of QS and impact of multiskilling diversification on quantity surveyors firms' performance on a five-point Likert scale ranging from 1 to 5, where 1 represents "Insignificant" and 5 represent "Very significant".

### 2.2 Sample Structure

Purposive sampling techniques was employed in reaching out to the respondents, since this study involved the opinion of experienced QS. This is supported by Adeyemo & Smallwood, (2017) who affirmed that more reliable data can be gathered from experienced respondents. Accordingly, a sample of 80 registered quantity surveying firms were selected within F.C.T, Abuja. Though, there are several methods of administering a questionnaire survey, direct delivery of the questionnaire by hand was preferred, and 60 questionnaires were received, making

75% responses. This was considered adequate for analysis based on the assertion by Spillane et al. (2012) that the result of a survey could be considered as biased and of little importance if the return rate was lower than 20-30%.

### 2.3 Cronbach's Alpha Reliability Test

Cronbach's Alpha coefficient test is used for evaluating the reliability of the instrument. The measure is considered to be reliable if the value of Cronbach's Alpha coefficient equals or exceeds 0.70 (Tabachnick & Fidell, 2013). In this study, the values of Cronbach's Alpha coefficient for the construct ranged from 0.703 to 0.846. Since these values were more than 0.7, the entire construct as well as the variables was believed to have demonstrated a good reliability to be measured on the same latent trait and scale.

### 2.4 Data Analysis and Discussion
### 2.4.1 Areas of multiskilling diversification of QS

The data was analyzed using the Relative Importance Index (RII). The performance of each parameter was evaluated based on the importance weighting and the proposed efficiency of each variable. The results of the RII from Table 1 shows that valuation skills was first in ranking with RII (0.980), project management skills was second with RII (0.850), facility management skills as third ranking with RII (0.840), arbitration skills and risk management skills with RII (0.820) were ranked fourth, property investment funding skills with RII (0.810) was ranked sixth, insurance skills with RII (0.803) was ranked seventh, while, ICT skills, development appraisal skills, and research and development skills with RII (0.800) were ranked eigth.

Table 1. Areas of multiskilling diversification of QS

| Skills | V-High | High | Neutral | Low | V-low | RII | Rank |
|---|---|---|---|---|---|---|---|
| Valuation skills | 270 | 24 | 0 | 0 | 0 | 0.980 | 1st |
| Project management skills | 195 | 36 | 9 | 12 | 3 | 0.850 | 2nd |
| Facility management skills | 120 | 96 | 36 | 0 | 0 | 0.840 | 3rd |
| Arbitration skills | 120 | 96 | 18 | 12 | 0 | 0.820 | 4th |
| Risk management skills | 105 | 96 | 45 | 0 | 0 | 0.820 | 4th |
| Property investment funding skills | 120 | 72 | 45 | 6 | 0 | 0.810 | 6th |
| Insurance skills | 90 | 100 | 51 | 0 | 0 | 0.803 | 7th |
| ICT skill | 90 | 108 | 36 | 6 | 0 | 0.800 | 8th |
| Development appraisal skills | 120 | 72 | 36 | 12 | 0 | 0.800 | 8th |
| Research and Development skillss | 90 | 96 | 54 | 0 | 0 | 0.800 | 8th |

Source: Author's Field Survey, 2023

The RII can be equal to 1, with a higher factor implying perfect significance, while a RII less tan 0.5 implies insignificance (Chan & Kumaraswamy, 2002). The results of RII as shown in the seventh column of Table 1, ranges from 0.800 – 0.980. This implies a perfect significance, which indicates how much more the áreas of multiskilling diversification are important for QS services. The results upheld the perception of Shafie et al. (2014) who depicts that QS is expected to contribute throughout the entire lifespan of the construction project in a more managerial capacity. The findings also agrees with Chamikara et al. (2020) who described QS as the amalgamation of several other disciplines.

### *2.4.2 Impacts of multiskilling diversification on QS firms' performance.*

The results of the RII from Table 2 shows that enhanced organizational image with RII (0.879) was ranked first, enhance job coordination, and fastened job/service delivery with RII of 0.870 were ranked second, while, enhanced quality of service with RII (0.849) was ranked fourth, increase profitability was ranked fifth with RII (0.828), contribute to economy development with RII (0.780) was ranked sixth, Improved international competitiveness with RII (0.759) was ranked seventh, Shortened service process with RII (0.729) was ranked eighth, Increased opportunities for the development of process innovation and technology implementation with RII (0.720) was ranked ninth.

Table 2. Impact of multiskilling on quantity surveyors' firms performance

| Impacts | RII | Rank |
|---|---|---|
| Enhanced organizational image | 0.879 | 1st |
| Enhance job coordination | 0.870 | 2nd |
| Fastened job/service delivery | 0.870 | 2nd |
| Enhanced quality of service | 0.849 | 4th |
| Increase profitability | 0.828 | 5th |
| Contribute to economy development | 0.780 | 6th |
| Improved international competitiveness | 0.759 | 7th |
| Shortened service process | 0.729 | 8th |
| Increased opportunities for the development of process innovation and technology implementation | 0.720 | 9th |

Source: Author's Field Survey, 2023

The results of RII as shown in the third column of Table 2, ranges from 0.720 – 0.879. This implies a perfect significance, which indicates how much more the impact of multiskilling diversification are on quantity surveyors' firms performance. The results indicate that multiskilling diversification is very effective. This is in line with the opinión of Perera & Pearson, (2011) who argued that the changing nature of the construction and development industry such as the adoption of innovative technological processes and development necessitate a much stronger emphasis on professional competencies.

## 3.0 CONCLUSION

Drawn from the results, implies a perfect significance, which indicates how much more the áreas of multiskilling are important for QS service diversification and how much more the impact of multiskilling diversification are on quantity surveyors' firms performance. The results revealed that the proliferation of knowledge in the construction sector coupled with the impact of technology in the workplace required service firms to maintain service delivery within the ambit of business advances and development. It was thus recommended that principal partners, operation managers and human resource managers should encourage QS to diversify in new marketable areas of optional competency to ensure business development and sustainability.

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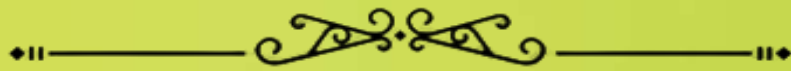
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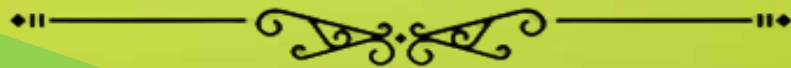
# OUTDOOR LEARNING IN ISLAMIC EDUCATIONAL INSTITUTIONS ENVIRONMENT

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## ABSTRACT

This study delves into the realm of outdoor learning in the context of Islamic Educational Institutions (IEIs), considering their unique cultural, religious, Islamic Garden, and pedagogical paradigms. Outdoor learning, which often underused in many educational Islamic settings, can foster a diverse array of learning outcomes, including enhanced cognitive skills, social development, physical well-being, and environmental stewardship. However, the implementation and impacts of outdoor learning in the environments of IEIs have been relatively unexplored. The research seeks to address this knowledge gap by investigating how outdoor learning is currently implemented in various IEIs, identifying the perceived benefits and challenges, and outlining potential strategies for integrating outdoor learning more effectively within these institutions. Through a mixed-methods approach incorporating surveys, interviews, and case study analysis, we examine the perspectives of teachers, students, and administrators across multiple IEIs. The findings suggest that outdoor learning; when integrated with Islamic teachings and values, can provide a rich, experiential platform for students to connect with the natural world and understand their role as stewards of the environment, a concept deeply embedded in Islamic ethos. However, resource constraints, a lack of training, and a traditional focus on classroom-based learning present substantial barriers. The study concludes by proposing landscape to be a framework for effective integration of outdoor learning into the curriculum of IEIs. It emphasises teacher training, curricular reforms, community involvement, and the creation of a supportive landscape as key aspects in promoting a sustainable and holistic outdoor learning environment in line with Islamic principles. This study fulfils the purpose and objective of the research by obtaining the priority of the definition of Institutions of Islamic education and the landscape of Islamic Gardens, which includes the relationship of space, place, user needs, and Islamic atmosphere in forming an approach to improving learning.

*Keywords: Outdoor Learning, Islamic Institutions, Islamic Garden.*

## INTRODUCTION

There are numerous definitions of outdoor learning or outdoor education, Akmal Goh Abdullah and Nor Haslina Jaafar (2014) argue that these definitions may be divided into two groups: "psychosocial Definition" and "environmental Definition" in Nangkula Utaberta's works. CA Lewis (1975) defined external learning in terms of the 'psychosocial definition' as the use of senses for observation and perception, including taste, touch, smell, hearing (audio), and vision (visual). A method of learning through activities completed outside of a confined place is known as external learning. (out-of-door). An outer learning approach or education is based on contextual experiences had or that have been applied primarily from exposure to the outside world, claims Priest (1988). (out-of-door). The link between people and natural resources is the focus of the topic of external learning. Outdoor learning, according to Husamah (2013), is learning that takes place outside of a traditional classroom setting, such as playing in schoolyards, parks, or farming communities (fisherman), going camping, or engaging in other activities that foster both practical experience and the acquisition of knowledge. Students are exposed to external learning to prevent boredom and pique their desire for more in-depth learning. Adelia Vera (2012) defines outdoor learning as an activity that uses nature as a direct teaching tool to transmit concepts that are learned outside of the traditional classroom setting.

Using all of our senses, outdoor learning is a method of learning. It takes the lead, though not only because of exposure to the outdoors. The emphasis on the learning topic is placed on human-related connections and natural resources in external education. (Lund, 2002). The emphasis is on the learning process based on real facts and the system of experiences directly through the activities done so that it becomes meaningful or gives the student a lasting memory effect. Outdoor learning is the activities carried out outside the classroom to make learning more interesting and fun. It can be done anywhere. Outdoor learning is defined as activities that takes place outside of walls of buildings, can be done without any infrastructure or facilities being built, and may require a lot of land, water, or air as well as unaltered natural landscape areas to create activity spaces. The theory that education is formed in nature is a manifestation of education outdoors. The idea that nature serves as a learning medium is a solution to boredom and saturation with educational methods in the classroom. From this perspective, Walt Whitman renewed the method of education by focusing on activities outside the classroom. In this way, education and training outside the classroom can replace the conventional methods of education carried out in the classroom. As a result, the educational model is more focused on quantitative values, rather than on the process of deeper recognition of knowledge sources. (F Herry, 2008).

Outdoor learning is something that is closely related to time and place. (Brookes, 1991) Outdoor learning is "education in, for, and about the outdoor environment." Donaldson & Donaldson, 1958, Outdoor Education: A Definition, JOPER, 29 (17), Exterior learning is education 'in', 'on', and 'for' the environment. (Phyllis Ford, 1986) Outdoor learning is "a thing that has connections. This relates not only to natural resources but also to humans and society." (Simon Preist, 1986, Redefining Outdoor Education, Journal of Environmental Education, 17 (3), 13)

According to a study by Shuhana Shamsuddin (2007), it is stated that a good outdoor learning environment can encourage self-questioning and new discoveries, act as a learning medium, provide a place to discuss and exchange opinions, as well as a place for solitary learning and meditation. This learning environment allows students to enjoy the learning process more. In a statement from the Pacific Northwest Pollution Prevention Resource Centre (1999), "The more an individual feels that their health

and work (at home or in the school environment) improve, the more productive their ability to work (live or study) will also be. The learning environment needs to provide desired stimuli, such as stimuli for problem-solving, reducing stress, or increasing the pleasure of learning, while preventing unwanted stimuli such as stress and confusion (Knirk, 1979).

There are three ways of outdoor learning: 1) Formal Outdoor Learning, 2) Informal Outdoor Learning, and 3) Non-formal Outdoor learning.

## 1) Formal Outdoor Learning:

Formal outdoor learning refers to structured educational activities that are intentionally planned, implemented, and assessed within a formal educational setting. It follows a predetermined curriculum and is typically delivered by trained teachers or educators. Examples of formal outdoor learning include field trips, outdoor science experiments, environmental education programs, or outdoor physical education classes. In this approach, specific learning objectives are defined, and assessment methods are used to evaluate student progress. David Sobel (2004) has conducted research and published articles on outdoor education and environmental education, emphasising the significance of formally Connecting Classrooms and Communities for learning.

## 2) Informal Outdoor Learning:

Informal outdoor learning takes place spontaneously and organically, without a predetermined curriculum or formal structure. It occurs outside of traditional educational settings and is often driven by personal interests and curiosity. Informal outdoor learning can happen during leisure activities, family outings, visits to parks, or exploration of natural environments. It provides opportunities for unstructured play, discovery, and self-directed learning. Although not explicitly planned as educational experiences,

these informal outdoor activities can contribute significantly to a person's knowledge, skills, and understanding of the natural world.

David Sobel (1998) was the one who investigated the role of particular places in children's lives and how they contribute to informal learning. David Gruenewald (2003) also discussed the importance of experience and connections with place in informal learning. Tim Gill (2007) has researched the role of play and child exploration in informal learning and discusses the importance of giving children the freedom to experience the outdoors in a meaningful way for their informal development. Likewise, Richard Louv (2005), emphasised the importance of outdoor experiences in assisting children's comprehensive informal development.

## 3) Non-formal Outdoor Learning:

Non-formal outdoor learning lies between the formal and informal approaches. It involves structured educational activities that occur outside the formal classroom setting but are intentionally designed to achieve specific learning outcomes. Non-formal outdoor learning programs may be organized by schools, community organizations, or youth groups. Examples include outdoor adventure programs, environmental camps, or outdoor leadership training. While non-formal outdoor learning incorporates elements of formal education, it offers more flexibility, experiential learning opportunities, and hands-on activities. Jim Dillon (2009): Outdoor learning and character development through nature-based recreation and nature conservation as outdoor education in a non-formal context. Jim Dillon (2009): Outdoor learning and character development through outdoor learning through outdoor recreation activities and nature preservation as outdoor education in a non-formal context.

It's worth noting that these learning approaches are not mutually exclusive,

and they often overlap in practice. Educators can incorporate elements of both formal and non-formal approaches in outdoor learning to provide a well-rounded educational experience. Informal learning, on the other hand, is less structured but can complement and reinforce both formal and non-formal outdoor learning experiences. The combination of these approaches can cater to diverse learning styles, promote holistic development, and foster a deeper connection with the natural world.

Abdul Salam Yussof (2015) wrote in his book al-Munqidh min al-Dhalal that according to al-Ghazali, learning is divided into three stages: ulam al-hissiyah, or knowledge acquired by humans through their minds; ulam al-aqliyah, or knowledge acquired by humans through their senses; and ulam al-laduni, or knowledge acquired directly by humans through their hearts through inspiration from Allah SWT. These three procedures, according to Al-Ghazali, are necessary for the development and production of ideal pupils. Saidina Omar advised parents to teach their kids to swim, ride horses, use nice stories and examples, and write lovely poems. (1993; Tajul Arifin). This verse demonstrates how learning can be accomplished both intellectually and spiritually, not just via cognition but also by energy exertion. Al-Ghazali contends that there are two aspects to learning: the physical (action) and the spiritual. In real life, both affect and impact one another.

According to Sidek Baba (2017), the Science of Education is not only in obtaining results from thought alone; knowledge is also obtained through observation and examination. It is also the source of inspiration from Allah S.W.T. and the grace given to make knowledge about the clear (the surroundings) and the hidden interconnected. The heavens and the earth, the mountains and the seas, are signs of the greatness of Allah.

The Malaysian Ministry of Education (KPM) introduced outdoor learning in 2000. According to the Ministry of Education of Malaysia (2005), learning outside of a classroom (PLBD) is a planned and structured activity outside of the classroom. The objective emphasised in external learning is to prepare students to learn something, either as a title or concept or as a learning process. The main objectives of external learning consist of three: knowledge, attitude, and skills. In addition, it can also strengthen the student's understanding of the concepts learned in the classroom by providing learning experiences in real, meaningful, and fun situations. Later, it also allows adult students to think and master science through contextual experiences, enhance student interest and attitude to learn; and develop skills to collect, process, and analyse data as well as information. External learning can also apply pure values to students directly and indirectly. KPM has also created the Out-of-Class Learning Guide Line (PLBD) in the 9th Malaysia Plan (RMK-9), Education Development Master Plan 2006–2010, and Malaysia Education Development Plan 2013–2025, with the PLBD aiming to focus on the comprehensive development of students' effectiveness in terms of physical, spiritual, emotional, and intellectual aspects. (KPM, 2013).

This study meets the purposes and objectives of research by obtaining the priority of the definition of outdoor learning through the Islamic institution and Islamic Garden, which includes the relationship of space, place, user needs, and Islamic atmosphere in forming learning approaches (pedagogy) and methods of memorise (hafazan). To use the method of memorise (hafazan) to design Islamic gardens inspired by the plants carefully chosen to meet the local environment is to draw back the paradigm of the Qur'an.

This thesis examines the overall benefits of learning outside the natural environment for students at the Islamic institute to identify the approach to external learning and the effectiveness of the benefits among students at the Islamic institute towards memorising. (Hafazan).

This study also examines the rules of memorise (a ḥifẓ), reading (tilawah), perfection (tajwid), examination of translation (tafsir), and laws and practises (tabii) through external learning. The custom of learning techniques used in teaching and learning Islamic institute is a technique that uses a variety of trends such as listening, seeing, reading, and writing to memorise through teaching methods (Talqin), training (Takrar), love of the Qur'an (Al-Mel), and understanding (al-Fahm) that require the skills of natural touching as a factor and factor of formation and influence the power of the method of memory (hafazan). Hassan Langgulung (d. 2008) and Che Noraini Hashim (2014) affirm that Islamic education based on Ibn Khaldun includes theology, figh, Quran, and Hadith as 'ulum naqliyyah', 'ulum aqliyyah, tassawwuf, medicine, agriculture, and other disciplines.

According to Anderson (2002), Brookhart (2012) stated that learning needs to go through the basics of thinking skills to allow humans to see different perspectives to solve problems in a particular situation. According to al-Qabisi (1955), thinking is the function of the mind that observes all energy so that the human brain can work and operate best for the learning process. (Mohd Syaubari Bin Othman, 2018).

**AIM AND OBJECTIVES OF THE STUDY**

Understanding the relationship between the landscape of Islamic educational institutions for students through external learning as a medium and method that helps students to explain the problems of learning. Determining the information and theories of previous studies relating to the scope of the study, consisting of three: 1) outdoor learning landscape environments, 2) Islamic Garden landscapes, and 3) the development of Islamic Education Institution landscapes.

Objective 1, determines the relationship of the area of the environment of the outdoor learning landscape between the outdoor and interior space as the needs of the student user. The outdoor learning

landscape environment also helps to find out the benefits of external learning. The relationship aspect of the environmental area is created through two aspects of the relationship, namely 1) Exposure to Outdoor Learning by students and educators. 2) Effectiveness through external learning experience by students and educators.

Objective 2, is to identify the factors that can influence students in the process of designing an outdoor learning landscape as a medium to help improve the ease of learning.

## LITERATURE REVIEW

### 2. BENEFITS OF OUTDOOR LEARNING

In the study, Beard and Wilson (2002) and Bixler et al. (2002) suggest that learning outside the classroom can give students the opportunity to explore, giving them freedom, generating creativity and pleasure, triggering side learning, and fostering social competence because of the nature of human investigation itself. Waite and Rea (2007) also agreed that learning outside the classroom can generate permanent memory if studied outside the school and is often associated with positive responses from students and teachers. Additionally, learning outside the classroom is preferred because it indirectly improves the student's skills.
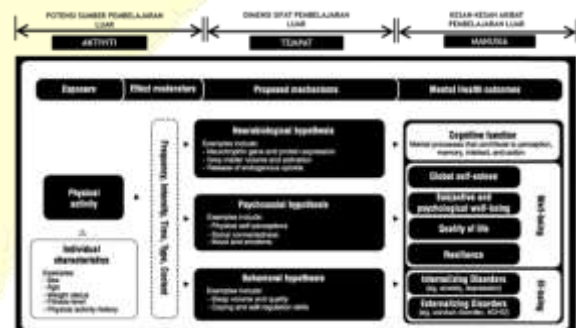


**Table 1:** Benefits of Concept Outdoor Learning

Outdoor learning studies show that active movement, integrated subjects, and experience in the context of learning are the most effective ways for students to

learn (Bass, Yumol, & Hazer, 2012; Bredderman, 1983; Chen & Chou, 2015; Fägerstam, 2014; Haury & Rillero, 1994; Jones et al., 2015; Parry, 2011; RAFT, 2013; Scott et al., 2013; Thornburn & Marshall, 2014); Wiggins & McTighe, 2008 (as cited in James & Williams, 2017). This can be achieved by providing an area for an outdoor learning experience within the school environment. (Broda, 2011). Outside learning promotes imagination and creativity, increases motivation to learn, and enhances social relationships. (Broda, 2011). Behaviour has an adverse effect that triggers a decline in interest in academics, a lack of stimulation, and a lack of confidence, which can subsequently affect the motivation of students to continue learning. James and Williams (2017) stated in their study that giving students opportunities to experience the environment directly can enhance student motivation to learn, build self-confidence, and help develop behaviour. According to Erickson and Ernst (2011), external learning can develop all senses, develop students' imaginations, relax the brain, and restore memory. Spending time in nature has many benefits, such as improving skills, improving fitness, and activating the physical and mental systems. In addition, it can physically generate health in the body and reduce obesity that occurs in the presence of activity that generates movement in the body. (Fjortoft, 2001). Experiential external learning aims at the development and growth of cognitive, psychomotor, and affective domains simultaneously without ignoring any of these components. (Md Amin Md Taff, 2011).

Through sensory memory elements of colour, writing, images (physical images), and visual popouts on the vision, students can be captured by the vision when looking at the image and can create mental images in the student's memory. This will shake the sensory memory to hold the memory, which will then be processed and stored in the short-term memory. For long-term memory processing, such visual information needs

to be repeated and cognitively derived from activities carried out in the field. (Morris dan Maisto, 2002; Wan Akbar Wan Abdulah, Nursafra Mohd Zhaffar, 2018). Outdoor learning is an student practitioner's relationship in a variety of ways that acts as a facilitator, using a wide range of sense and experience approaches. It encourages students to engage in emotional, physical, static, spiritual, and cognitive experiences as part of the learning process. The place or context in which learning occurs is an important part of the learning process, as described in Figure 1.1. The relationship between people, the activities involved, and the place where the learning process occurs over a certain period of time create learning opportunities.



**Figure 1:** The Learning Process (Higgins, P, 1995)

## 2.1 PLACE

Place and space are key concepts in many fields of philosophical debate research, including human geography, sociology, and environmental psychology. Gruenewald and Smith (2008) saw out-of-the-spot-based learning initiatives as social drivers for wider expansion. A place is an important concept in exploring the relationship between pedagogy and the place where external learning is carried out. Wattchow, Brian, and Brown, Mike ( 2011) A place is a place where experience and position are gained.

According to Higgins, P. (1995, the place plays a good role in shaping the sense of the place itself and forming outer learning. A place is a relationship between a space of activity with other organisms and the environmental landscape as a result of the direct involvement of external learning. The place is where the Planner and

Architect investigate and plan, as well as create spaces and activities through it. A place gives shape and structure to an area.



**Table 2:** The aspect of uniting the differences in human interaction with the environment and between space components. (Sources by: Altman & Low (1992) (Hashem et. Al 2013).

Places affect tastes, emotions, cognition, and behaviour, as suppressed by several studies classified into different scales (Hashem et Al., 2013). A place can give birth to a taste that is classified into scales based on the understanding that a place has a variety of meanings and inspirations at different levels. (Stedman, 2002). The same statement from Lynch (1960) states that the place of birth identity varies between one place and another and may vary inspiration differently for each person. According to research by Altman & Low (1992) and Hashem et al. (2013), a place can create three principles of relationships: cognitive, behavioural, and emotional dimensions. The cognitive aspect is caused by the perception of the characteristics (geometry and shape) of space. The behavioural aspect refers to the functional relationship between space and activity. The provision of suitable locations can help external learning be effectively transferred to students.

## 2.2 SPACE

In general, there are three types of learning activities: passive, active, and interactive, each of which requires a different space specialisation. (Knirk, 1979). In theory, human activity takes place in space. To act effectively, the space formed requires the mental representations of the human being. It is constructed on the basis of the elements that exist within the space and the spatial relationships between them based on a period of time (relative to a reference frame) (Vol. 35, 'Environment and Behaviour, Jan. 2003). Shuhana Shamsuddin (2007) explains in her study that mental images are experienced or can be lived from various sources, either by seeing, hearing, touching, depicting (imagining), or even through language. From another angle, all life depends on the environment around it to support its expression; the behaviour is usually limited by some features of the physical environment through the built space. It is guided not only by self-purpose but also by the cognitive processes it goes through, depending on how the individual reads, interprets, and depicts his or her environment. The above illustration directly shows the importance of space planning, location, and building relationships in the development of education in order to create a more conducive outdoor learning environment.

## 2.3 USER NEEDS (ACTIVITY)

Gehl (2006) stated that if the physical quality of the space and the outer space, i.e., the needs of the user, are severe and unconnected, then the activity cannot run properly. When user needs are well connected, the desired activity will occur with the same frequency, and at the same time, it will motivate people to do outdoor activities. The pattern of activity is not only determined by the function of space with the availability of facilities, shade or growth plants, or a good physical setting. On the contrary, the structure of space layout and the diversity of use and function affect the pattern of activity. According to Montgomery (1998) and Irsyad Adhi Waskita Hutama (2016), an activity itself is the result of two separate but related concepts: fitness and diversity. The first concept refers to the number of people (movement and flow) inside and around the place or space. Spatial fixations are formed based on the type of physical activity, the activity performed, or the needs of the user. Space relationships and space settings are designed based on the needs of the user, the activities carried out, and the functional requirements required. (Shuhana Shamsuddin, 2007). The study

also explains that the application of user facilities, access facilities, and facilities for the management of planning activity between spaces and buildings can correspond with borders for maintenance and control, in addition to promoting internal and external communication as a link to stimulate the interaction between indoor and outdoor spaces for learning.

## HISTORY OF ISLAM EDUCATION.

Education and learning of Islam start from the descent of the first revelation to the Prophet Muhammad S.A.W in the Gua Hira' Surah Al-Alaq, which has five short verses meaning:

"Read! In the Name of your Lord, Who has created (all that exist, Has created man from a clot. Read! And your Lord is the Most Generous, Who has taught (The writing) by the pen. Has tough man that which he knew not " (Al-'Alaq 96: 1-5).

This is the beginning of the learning of Islam, which gives knowledge and education, which means "teaching". Aisyah r.a. said that the Prophet Muhammad saw that on the 17th of Ramadan in 610 Masihi, Allah sent the angel Jibril a.s. to deliver the first revelation to Muhammad in the remote cave. The Angel of the Prophet Muhammad SAW (read) He then replied, "I don't know how to read." Jibril then hugged the prophet very tightly, so that he felt drowned. The Prophet (peace be upon him) taught him three times to read the Qur'an. In the first five verses, God repeated the word of knowledge three times and also touched on the use of a pen, which is the writing that became a useful medium in the transmission of knowledge. This shows how God emphasises the demands of science for man. Science is able to be the light of the vessel to guide man out of wickedness towards a more civilised life. This verse was revealed to the Prophet Muhammad (peace be upon him) for mankind about the demands of reading and knowledge, while he himself did not know how to write

or read at that time. From here, it can be seen that learning is more effective for building human civilization and, at the same time, developing people. Allah has revealed this as a motivation for mankind to gain knowledge and to begin learning Islam. (Nurazmallail Marni & Zulkiflee Haron, 2008; Muhd Yusof Ahmad, 2015). In the methodology of learning, hafazan is an important skill found early in Islamic education that uses the sources of the Qur'an. (Sidek Baba, 2017)
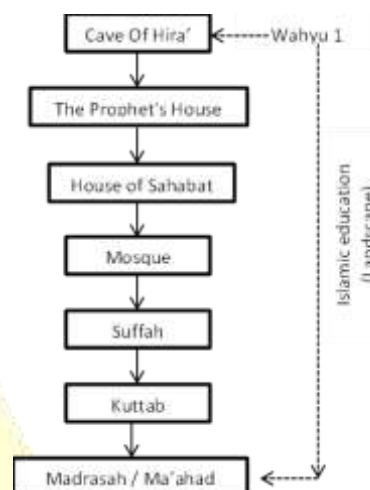


**Figure 2:** The Creation Of Islamic Institutions Along With Islamic Education.

## 3.0 DEVELOPMENT OF ISLAMIC EDUCATION

The term "Islamic education" means the description of Islamic education itself, which is rooted in the teaching of the Qur'an. Islamic education has an integration of epistemology that is based on Tawhid, the truth or divinity. Islamic educational institutions are usually referred to as madrasahs. Special education Islamic institutions usually offer two courses of study: a main course teaching is memorise Al-Qur'an (the one who memorises the whole Qur'an is called ḥāfiz); and a teacher (Mua'lim) that leads students to become accepted scholars in society. The curriculum consists of courses in Arabic, tafsir, sharī'ah (the Islamic law), hadith (the speech and deeds of Muhammad), mantiq (logic), and Islamic history. In the Ottoman Empire, Süleyman I introduced the study of hadith. Depending on the demands of education,

several madaris also offer additional advanced courses in Arabic literature, English, and other foreign languages, as well as world science and history. Ottoman Madaris, along with religious teachings, also teaches "style of writing, grammar, syntax, poetry, composition, natural sciences, political science, and ethics."

Al-Qabisi (1955) and Azmil Hashim (2013) also explain that the techniques used in the teaching and learning of Islam are techniques that use a variety of ways, such as listening, seeing, reading, and writing, in addition to the methods of instruction and learning, memorising the methods of talqin (teaching), Takrar (training), al-mail (love of the Quran), and al-Fahm (understanding).

Syed Muhammad Naquib Al-Attas (1991) and Hashim Musa (2013) said in the term Islamic education that learning from adult students outside can help students better understand the existence of God, learn the good that is given, and learn the greatness of Allah. They indirectly guided students to think outside the box, which is with the science of fardu `ain by each person and fardu kifayah by using talent and ability in the respective fields.
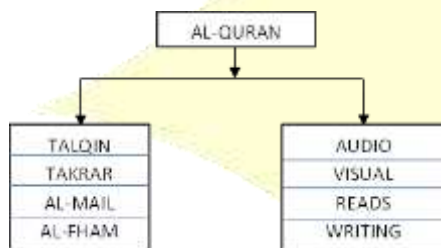


**Figure 4:** Modified from the Theory of adaptation of teaching and learning, remembering the Qur'an al-Qabisi (1955). (Azmil Hashim, 2013)

Beginning with the descent of the Qur'an and Hadith, the process of teaching Islam is gradually expanded to include the branches of knowledge of the Quran and Hadith such as tawhid (the knowledge of God), figh (the law), tasawwuf (sufism or spirituality), tafsir (the translation of the Qur'an), mustalah al-hadith (the methodology of Hadith), tajwid (the

reading of the Quran), and various aspects of the Arabic language such as nahu, nerve, and balaghah. These subject forms the traditional Islamic religious sciences, with tawhid, figh, and tasawwuf forming the silabus fardu ain.

| No | Subject |
|----|---------|
| 1 | Hifz Al-Quran &Tajwid |
| 2 | Fiqh |
| 3 | Tauhid & Mantiq |
| 4 | Tafsir Wa Ulumuhu |
| 5 | Hadith & Mutalaah |
| 6 | Nahu & sorf |
| 7 | Insyak & Mutalaah |
| 8 | Adab & Nusus |
| 9 | Arudh & Qafiah |
| 10 | Balaghah |

**Table 3:** The Islamic Institution's Subject

# THE ESTABLISHMENT OF ISLAMIC INSTITUTIONS IN MALAYSIA.

Islamic Institute in Malaysia was formed with the arrival of Islam in Malaysian territory, which is related to the development of Islam in Nusantara. It began with trade activities by the Arabs and Farsi because Nusantara was located in the middle of a sea journey between West Asia and held on to the historical fact that Islam had developed in Nusantara in the 13th century. In the historical records of the Yuan Dynasty in China, it is said that once Malay politics came to China, led by two Muslims.

This is reinforced by the records of Marco Polo, a traveller from Venice in 1292, and D.G.E. Hall, who said that Islam had developed in Perlak with the discoveries of the rocks of the Islamic kings in Sumatra. (Mohd Jamil Mukmin, 2012; Mohd Yusof Ahmad, 2015). From a series of histories according to al-Hadad (2001), Mohd Jamil Mukmin (2012), and Muhd Yusof Ahmad (2015), Islam had reached Kedah in the 9th century with Islamic Maharaja Debar 11 by Sheikh Abdullah bin Syeikh Ahmad al-Quamiri in 531 H (1111 M) at Bukit

Meriam Palace, Kota Kuala Muda. According to historical records, Malacca accepted Islam in 1414 and was developed by Sayid Abdul Aziz, an Arab merchant from Jeddah. Malacca was a strong centre of Islamic education during the reigns of Sultan Muzaffar Syah (1446–1456), Sultan Mansur Syah (456–1477), and Sultan Alauddin Syah (1477–1488). Since Melaka is a port, it is the name of the Islamic traders who came to pray, and according to D.G.E. Hall, the palace became the main centre of study and the centre of prayer, as well as the place of translation and storage of books besides the teachers' houses.

After the arrival of the invaders, the supporters were still walking in the teachers' houses, so that when many came to learn, the teacher's houses became secluded, and the surau and the Madrasah came to pass. Then many houses were built with the aim of studying nearby. It was a more practical and systematic Islamic study that has formed the whole of Malay so far today. From this foundation has been born a system of Islamic education that is coordinated with academic studies today, from the lower level to the university.

The term Islamic Institutions refers to the institutions of higher Islamic education. The study of the history of Islamic education means that the previous ma'ahad was a madrasah, translated into English as a school, college, or academic university. Islamic Institutions is a continuation of the former Islamic educational institutions consisting of mosques, suffahs, kuttabs, and madrasahs. (Nurazmallail Marni & Zulkiflee Haron, 2008; Muhd Yusof Ahmad, 2015).
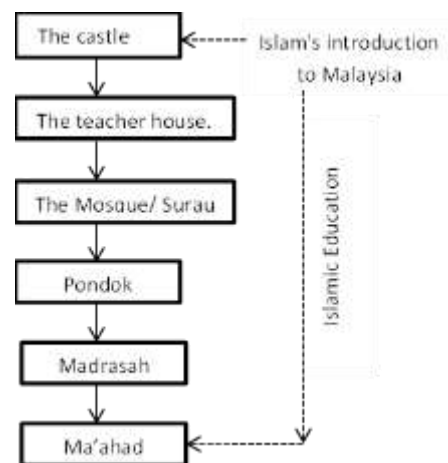


**Figure 3:** Establishment of Islamic Institutions and Islamic Learning in Malaysia

The arrival of British and Christian priests in the 19th had affected Islamic education in Malaysia by creating western education and issuing Islamic lessons in the field of education, which was replaced with plantation and maternity. The British have broken up Islamic education in Kedah, Perak, and Pulau Pinang by applying the English language and magnifying church education. Religious leaders have addressed this problem and have structured the Islamic learning system more complexly.

The first state to have a uniform and modern Islamic education system was Johor, where it originated under the rule of the Malacca descendants who lived in the Teluk Belanga, and with this Islamic Education in Johor under the authority of the palace. Johor was also the first state to use Jawi in official letters. The first Islamic Institute was built at the School of Quran Sri Kopi and School of Religion Kukup in Pontian, and then the Ma'ahad Johor was formed. (Mohd Hairudin Amin, 2012). The post-colonial Islamic education system is more systematic and formal than the "Pondok" system, with a diverse curriculum. The newly formed Islamic Institution had a more systematic and complete preparation and organisation, a curriculum of teaching that was structured above the awareness of the young people, and the adoption of Islamic Institutions by the Malaysian Ministry of Education (1978)

simultaneously with the coordination of the Islamic education policy. (KPM, 1992:24–24; Mohd Hairudin Amin & Kamarul Azmin Jasmi, 2012).

In Malaysia, Islamic institutions play a major role in the development of the study of the Qur'an, especially in the interpretation of the Quran. The establishment of Islamic institutions in Malaysia is to realise the philosophy of education in an integrated way in addition to producing *huffaz* who have skills in all areas of education. It also aims to produce huffaz who are skilled with the content of the Qur'an, knowledgeable, practical, faithful, and efficient with regard to the contents of the Quran, as well as knowing their knowledge in the community. According to Syed Muhammad Al-Naquib Al-Attas (1979), Islamic Education in Islamic Institutions in Malaysia refers to an integrated process to convey Islamic knowledge so that its recipients are spiritually, intellectually, and physically equipped to perform their roles as His servants and caliphs on earth (Khalifah). Islamic Institutions in Malaysia use 'Al-Attas' education to "implant and emphasise adab on humans"; adab basically shows the determination of mind and soul, the acquisition of the properties of the mind and spirit, the correct performance of the wrong and the right to the wrong actions, and the maintenance of humiliation. (Muhaidi, Mohd AlIkhsan, and Siti Salwa, 2015)

## ISLAMIC GARDEN

The creation of an Islamic Garden created more interactive relationships and goodwill among users and human activities. The main model for Islamic Gardens is in the Middle East, which is historically found in the Qur'an. There are 164 verses through 4 chapters that describe the colours (Al-Quran: Surah Al-Hijr: 26, 28, 33, Surah Ar-Rum: 22, Surah Abasa: 41), sounds, smells, spatial elements, microclimate, trees, flowers, and Paradise water. (52 ayat). The inspiration and ideas in the Islamic Park came from the emphasis on unique geometric patterns, complex water

features, and colourful planting schemes following the historical, philosophical, metaphysical, and poetic dimensions of the "earthly paradise." Islamic parks are landscapes designed according to certain ideological principles, using certain physical elements, and focusing on specific intentions. The articulation of these elements and intentions is deeply rooted in the teachings of the Islamic faith and in the culture of Islam.

Clark (2011) and Zainab Abdul Latif (2016) describe the second influential design element as the desert environment, which affects every aspect of life. The climate in the region is characterised by high average temperatures, high sunlight, strong winds, and heavy sandstorms. Finally, a lack of water is a limiting factor in design. From this original concept, they restricted and gathered resources in the heavenly area as a restriction to those resources that were indirectly mined and could be mined and used as a source of settlement for the formation of a garden. From the surroundings, you can see many traditional Islamic gardens surrounded by tall trees, walls, and buildings. This is a protective barrier to the climate, temperature, wind, and sandstorms that strike the area. This sparked the idea of the concept of personality described in the Qur'an. The composition also demonstrates the interpretation in different ways by different scholars: as an effort to isolate humans from the chaos of view around the desert and to protect the inhabitants of the garden from the dusty desert environment of sand and dust. It also serves as a limitation of vision between spaces by emphasising the secrecy of family members and women in particular, Creswell (1968) by Newton (1971); Lesiuk (1980); Hanachi, P.; Eshrati, P.; and Eshradi, D. (2011) saw clusters of high walls, buildings, and trees as prerequisites for privacy that realised the hidden attributes of spirit. Placing walls and buildings in the earthly garden is a metaphorical sign that recalls the gate; the desert surrounding it represents destruction and death, while within it are flowers, fruits, shadows, water, and life.

Overall, there is consensus that, due to the harsh climate in most Islamic countries and the high moral emphasis on family privacy, closed gardens have become a typical component of home rooms in the Middle East. El-Araby (1972); Al-Asad (2006); and the Mufidah Scientific Pharaoh (2015) explain that the most important element in the design of the historic park in the Middle East is the origin of water. At Alhambra, the use of water has been innovative, imitated, and enriched by most European designers across the Western world. Water resources play many roles in the design of the park, emphasising architectural elements, external sound dissolvers, creating pleasant sounds, irrigating plants, moisturising and cooling for hot and dry climates, and dusty winds, and providing resources for cleaning before worship. The ability of Islamic Garden designers to develop a method of irrigation from water shortages and the difficulty of bringing them to a park that is considered to be an important element in life is seen best.

Another important design element in the Islamic Garden is the plant. There are 13 chapters in the Qur'an that describe plants, one of which describes the sources of food for agriculture and plants in paradise. The designer has an interesting version of this paradise in the surrounding viewing area. The Muslims inherited the treasures of trees, semen, and flowers from the civilizations before them. The tall tyres and cypress trees provide climate protection. Elm trees, willow trees, and oak trees give shade in the summer and let the sun shine in the winter. In order to reduce the problems caused by the walls, high-leaf trees are used to filter dust and reduce the speed of the wind inside the park. These types of trees are planted throughout the eastern and western parts of the park and are used to cast shadows throughout the park throughout the day. The pine tree is used as a large-scale contrast. Animals are introduced to give animation to the park, including eagles, pigeons, ducks, and birds singing. Lemongrass trees and flowering trees are very popular in Islamic Gardens because

of their aromatic smells and fragrances. Fruit trees also have a priority in the overall design of Islamic gardens, not only as a source of food and colour but also as a canopy during the day and as a yard at night. This canopy can reduce the radiation of heat underneath it and make the canopy's protective area cold. Traditional designers spread this cool air from the garden through the house, thus creating a natural cooling system. Clark (2011) and Zainab Abdul Latif (2016).

## MAIN RESULTS

This section covers the level of data collection method (methodology) to be used, which consists of qualitative and quantitative methods, to complete this research and make comparisons between several Islamic institutions. Some information is obtained from document materials such as books, magazines, thesis reports, journals, articles, and others to reinforce key data. Below is a **Figure 4** of the methodological framework used in this study.

There are five stages in the overall framework of this study. The first level will identify the study background, problem statement, study gap, objectives, questions, and relevance of the study. The second stage is to determine the information and theories of previous studies related to the scope of the study, which consists of three parts: the outdoor learning landscape environment, the Islamic Garden Landscapes, and the development of institutional Islamic landscapes. The third stage is the level of data collection (methodology). To strengthen the key data, qualitative and quantitative techniques are used to collect the main data through a survey of question-friendly interviews with relevant parties and secondary data from people or institutions, journals, books, and the media. The fourth stage is the analysis of the data collected from the third stage, which is the main analysis that will be extracted into scheduling or in graphical form to produce accurate data. The final ranking will look for and discuss the data

collected; it will determine the outcome of the accuracy of the initial hypothesis and data.
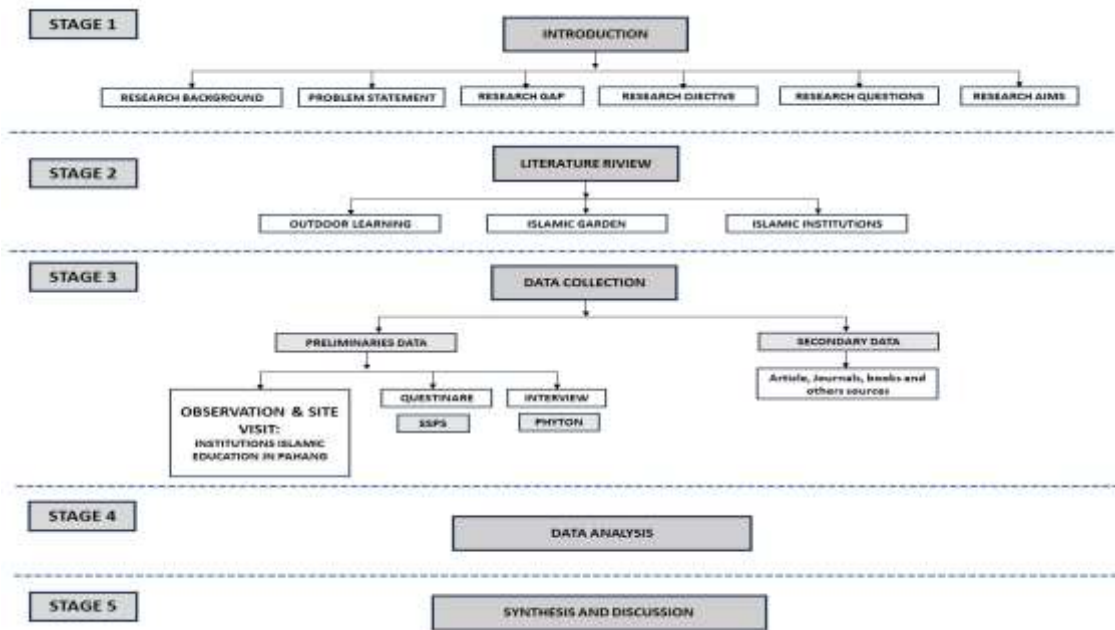


**Figure 4** Methodology framework
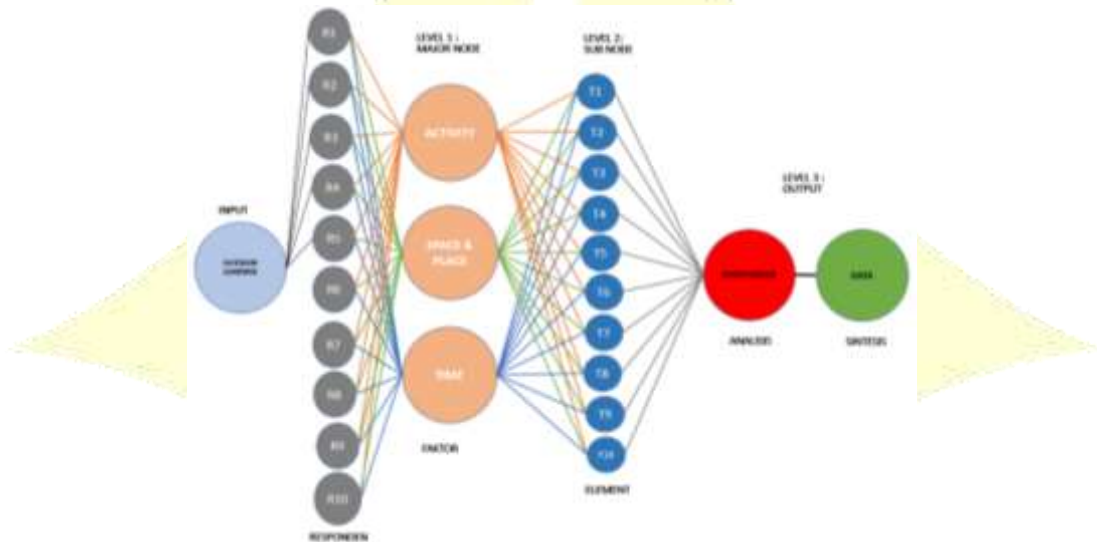


**Figure 5** Neural Network for Outdoor Learning by SSPS And Phyton

## CONCLUSION

This study identified the characteristics of of outdoor learning by emphasizing learning conditions conducive to mental development among students to address problems in achieving optimal learning. Therefore, all recommendations and guidelines of this study method will be considered as a reference to the design of the outdoor learning environment. The findings of this study are expected to benefit Islamic educational institutions, schools and governments to create design and produce institutions with structured and modern teaching methods (Pedagogy) through an outdoor learning with landscape environment to make balance and benchmarks for adult students to aid the improvement in Islamic education.

## ACKNOWLEDGEMENT

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# LANDSCAPE EVALUATION IN URBAN PARK FOR SENIORS RECREATIONAL ACTIVITIES

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## ABSTRACT

With the deepening of the ageing problem, urban parks are the main places for older adults to do daily activities, communicate, exercise and entertain.which aims to explore a new method of assessing urban parks' spatial layout characteristics that could improve older adults' physical and mental health towards a sustainable urban society. Yingze Park at Taiyuan City in Shanxi Province was selected as the case study. The Analytic Hierarchy Process (AHP) method has been used to measure the landscape preferences among older adults at Yingze Park. The evaluation consists of an on-site survey and observation of elderly activities at the park. The attributes of spaces and activities are the main components that were measured in this study. The main conclusions obtained in this paper are as follows: the comprehensive score of leisure space in Yingze Park for the elderly is 3.86, and the overall score of each park is between 3 and 4, indicating that the suitability of leisure space at Yingze Park is above moderate for the elderly. The activities in which the elderlies participate in the park include recreation, exercise, and social gatherings. Additionally, they also participate in cultural activities like dancing, tai chi, singing and opera singing. Leisure and entertainment activities are conducted in pavilions; exercise activities are conducted in open squares; social gatherings are widely distributed throughout the park. The layout and the design concept of urban park leisure spaces are essential in determining the preferences of the elderlies in doing their activities.

*Keywords : Small Urban Green Spaces, Urban Heat Island, Mitigation*

## INTRODUCTION

The world's population is now ageing. By 2030, the proportion of the population in the US, Japan and UK over 60 will rise to 26.1,27.8 and 37.3% [1], respectively. In China, due to the large population base, extended life expectancy and the continuous decline of the fertility age population, the proportion of the elderly population may rise to 25% or higher [2]. Urban parks can meet the multiple needs of the elderly for outdoor activities and are the central place for their daily activities,

communication, exercise and entertainment[3,4].

Participating in daily leisure activities is essential for the elderly to actively integrate into society and obtain emotional sustenance[2]. Physical activities can improve the physical health, while cultural and artistic recreational activities can alleviate cognitive decline and improve the quality of life and satisfaction of the elderly[3]. Social interaction would be able to regulate the emotional state of the elderly and their interpersonal communication[4], and enhance participants' happiness, satisfaction, security and sense of accomplishment[5]. It can be seen that daily leisure activities have become an important part of the life of the elderly. An in-depth investigation of the activity preferences of the elderly in the park is crucial in understanding the needs of the elderly and its influence on the spatial planning and design of the park. By evaluating the park landscape characteristics from the perspective of the elderly, we can provide a theoretical basis for the design layout that meets the needs of the Elderlies' activities at the park.

## METHODOLOGY

### Study Area

Yingze Park (Figure 1) is the first park built after the liberation of Taiyuan city, with convenient transportation, which is one of the important places for people to rest and visit. Yingze Park was built in 1954 and covers a total area of 666,900 square meters. Yingze Park is loated in northwestern Yingze District,brodering Yingze Street to the north, Qingnian Road to the east, Nansha River to the south and Jiefang Road ito the west; it is a large comprehensive park in Taiyuan. The functional space is composeed of six areas: Cultural and leisure area, science area, entertainment area, management area, production area, children's activity area.



**Figure 1** Yingze Park Layout Plan

## Variables Measured and Analysis

In this paper, AHP method is used to establish three criterion layers, including the leisure area, fitness area, and communication area. Figure 2 shows the Evaluation Index system for the suitability of leisure space in urban parks for the elderly. A set of survey questionnaires was constructed for Yingze Park visitors. The questionnaires were distributed to the park manager and elderly group organisation. In order to complete the questionnaire, each level index was compared with two factors, through sorting experts scoring data
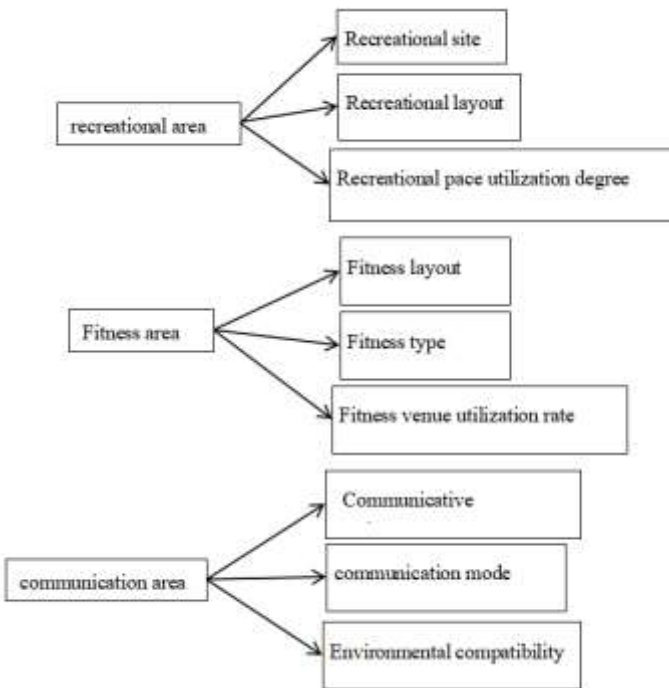


**Figure 2** Evaluation Index system for the suitability of leisure space in urban parks for the elderly

The data results of expert scoring was sorted out, and the relative judgment matrix of criterion level and target level were established. The relative weight of each index was calculated and its consistency was tested, so as to make the weight value more scientific. Based on the calculation formula of AHP, the construction of the judgment matrix, the relative judgment matrix of the index layer and the calculation is shown as in Table 1 and Table 2. The relative weight of the

criterion layer and the index layer, and the product is the comprehensive weight of each evaluation index relative to the target layer.

**Table 1** Meaning of each scale value

| scale value | Factor i as compared to factor j |
|---|---|
| 1 | **coordinate with** |
| 3 | It's a little important |
| 5 | Obviously important |
| 7 | It's very important |
| 9 | Extreme importance |
| **2，4，6，8** | **The median value of the two adjacent judgments** |
| count backwards | $a_{ij}=1/a_{ji}$ |

**Table 2** Weight value and ranking of each evaluation index

| Metric | Leisure Area | Fitness area | communication region |
|---|---|---|---|
| leisure area | 1 | 2 | 3 |
| Fitness area | 0.5 | 1 | 2 |
| communication region | 0.333 | 0.5 | 1 |

## RESULTS

The calculation result of hierarchical analysis showed that the maximum feature root was 3.009, and the corresponding RI value was 0.525 according to the RI table, so CR=CI/RI=0.009 <0.1, which passed the one-time test.

the questionnaire was made according to the landscape evaluation of the leisure activities of the elderlies, and scored from 1-5 points according to the five grades of Likert [10], which are very unsatisfactory, unsatisfactory, general, satisfied and very satisfied.

### Park Spaces and Activities

**Table 3** Weight value and ranking of each evaluation index

| Target layer | The standard | Weighted value | Index layer | Weighted value | Comprehensive weight |
|---|---|---|---|---|---|
| Evaluation system for the suitability of urban park leisure space for the elderly | Leisure area | 0.54 | A leisure space | 0.5889 | 0.3180 |
| | | | B Leisure layout | 0.2519 | 0.1360 |
| | | | C Leisure site utilization | 0.1593 | 0.0860 |
| | Fitness area | 0.30 | D The Fitness Layout | 0.5390 | 0.1617 |
| | | | E Fitness type | 0.1638 | 0.0491 |
| | | | F Fitness venue utilization rate | 0.2973 | 0.0892 |
| | Communication region | 0.16 | G Communicative Environment | 0.5571 | 0.1671 |
| | | | H communication mode | 0.1226 | 0.0196 |
| | | | I environment the circumference degree | 0.3202 | 0.0512 |

Based on the above table 3 we obtained elderlies pay more attention to the layout of urban park leisure spaces.Descriptive statistics show that leisure area (0.54)> fitness area (0.30)> communication area (0.16) .This indicate that the elderlies pay more attention to the construction of urban park leisure space. The score of the fitness layout index of the park is high, indicating that the fitness layout of Yingze Park is reasonable and in line with the law of fitness activities for the elderly. Therefore, Yingze Park should optimize the environment of the communication area and the environmental enclosure degree.

**Table 4** Participation of elderly activities in the park

| Type of activity | Athletic events | Number of participants |
|---|---|---|
| Leisure and entertainment | A: chess and card class | 10 |
| | B: sing, reading | 21 |
| | C: viewing | 15 |
| | D: Painting, sketching, calligraphy | 12 |
| | E: take a photograph | 5 |
| | F: stroll in the park | 8 |
| Sports exercise class | G: Dance, play tai Chi | 31 |
| | H: kicking shuttlecock, ball class | 16 |
| | I: weapon exercises | 5 |
| | J: Personal exercise | 6 |
| | K: run, walk | 4 |
| Social gatherings | L: chat, party | 10 |

The collected questionnaire activity data were collected to calculate the number of elderlies participating in different activities, as shown in Table 4. The events with the largest number of participants were dancing and Tai chi, and the activities with the least number of participants were running and walking. Figure 3 shows the most participated activities of the elderly in the park Which were leisure and entertainment activities and exercise activities.

**Table 5** Preference of activity spaces

| Movement Area | Site type | Type of activity | Activity name | Activity number |
|---|---|---|---|---|
| Northgate waterside pavilion | Corridor pavilion | Leisure and entertainment | A、B | 26 |
| Belvedere | Pavilion | | C | 6 |
| Peony garden, Begonia garden, Magnolia Garden, Rose garden | Plant specialized garden | | C、D、E、F | 25 |
| Bonus plank road | Gallery Bridge | | C、A | 7 |
| LinShuiXuan | Pavilion | | D | 7 |
| depository of Buddhist texts | Square | Sports exercise class | G、H | 25 |
| North gate square | The entrance square | | G、H | 22 |
| Fitness area | Fitness square | | I、J | 11 |
| runway | Garden road | | K | 4 |
| Sunshine lawn | Lawn | Social gatherings | L | 10 |
| children playing space | Square | Education care | M | 9 |
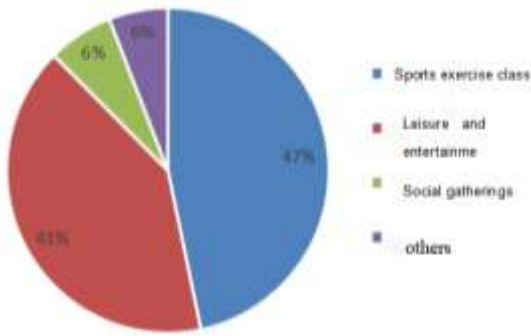
**Figure 3** Type of activity participation by older elderly

## Diversity of Activities

Leisure and entertainment activities are mostly carried out in repitition and plant gardens. For example, chess and card games were mostly carried out under the corridor pavilions such as the north gate waterside pavilion and lotus appreciation walkway. It shows the preference of elderlies on activity spaces(Table 5 ).

Playing chess and card Games do not require much of the surrounding scenery but it needs to have a proper seating with tables and other facilities that are comforting for them. Other activities like calligraphy and sketching are more passive (Figure 4). The good natural environment and human environment in the park may become a place for the elderly to move. The Peony Garden, The Begonia Garden, The Magnolia Garden, Rose Garden and other plant gardens that provide view to the Yingze Lake offer a good natural scenery and cultural landscape that meets the needs of the elderlies. Activities that involve loud noises like singing and playing music (Figure 5) require a separate large venue with good privacy so that it will not disturb other visitors. Therefore, spaces with dense vegetation are more suitable as it can function as noise buffer.

According to the investigation, it was found that the activities of the elderly at Yingze Park are relatively diverse. The elderly engages in leisure and entertainment activities at the pavilion and gardens.

Meanwhile, most of the exercise and active activities were conducted at the open square. Exercise activities do not require much landscape, but the site requires the open and flat space, which is usually done at the park square in the park square. Other activities like dancing, Tai chi, kicking shuttlecock usually require large open spaces, and has shade facilities (Figure 6).



**Figure 4** Practicing calligraphy and sketching



**Figure 5** Playing music and singing



**Figure 6** Dancing and Tai Chi

Social gatherings have no specific activity areas and are widely distributed throughout the park. Chatting and parties are mostly carried out in garden buildings such as hard squares or covered bridges, with a certain sense of enclosureWhich is not closed and safe. The elderly can enjoy the scenery and chat in the Peony Garden.

## Reliability Analysis

Select the elderly travel higher period (9:00-11:00,15:00-17:00), the elderly in the activities in the Yingze Park activities type and project survey, through Excel table preliminary statistical analysis, the

number of participants in the project, and the reliability of the questionnaire survey data results, credible data is analyzed to the elderly in the Yingze Park activity site selection.

The data of the recovered questionnaire was sorted out, and the average score of each factor for the suitability of the leisure space in urban parks to the elderly was calculated.the score for the suitability of the leisure space in urban parks

The questionnaire was made according to the landscape evaluation of the leisure activities of the elderlies, and scored from 1-5 points according to the five grades of Likert [10], such as very unsatisfactory, unsatisfactory, general, satisfied and very satisfied.

The Cronbach coefficient was used to judge the credibility of the questionnaire survey. Confidence analysis of the number of people participating in different activities in the park Was analysed using SPSS PRO. If the Cronb α coefficient above 0.9, that means  the questionnaire reliability is very good, if the results are between 0.8-0.9 that means the questionnaire reliability is good, If the results are between 0.7 - 0.8, the said reliability is acceptable but needs modification; whereas if it is in the range 0.6 - 0.7, the data must be checked again. Additionally, if the results are between 0.5 - 0.6, the reliability is not ideal and if it is below 0.5, it indicates that the questionnaire survey reliability is very poor, which means that there has to be alteration to the questionnaire.

**Table 5** The Cronbach's α coefficient table.

| The Cronbach's α coefficient | Normalized Cronbach's α coefficient | Sample number |
|---|---|---|
| 0.832 | 0.84 | 13 |

Table 5 shows that the value of Cronbach's α in this questionnaire survey is 0.832. the Cronb α coefficient is between 0.8 and 0.9, indicating that the reliability of the questionnaire is good. Suggestions can be made for the park environment construction according to the activities of the park and the characteristics of the activity venues obtained from the questionnaire survey.

## DISCUSSION

As the group with the highest frequency of urban parks, People had high preferences for urban park whit a high variety of element[11]. the elderlies have four categories of park activities: leisure and entertainment, exercise, social gathering and education and care. Ways to design the park environment to meet the needs of the elderly has become the focus. It is suggested to set up semi-open corridors and pavilion spaces for leisure and entertainment activities, using trees, shrubs, hedges and other plants combined with micro-terrain isolation, and configure leisure seats, toilets and other infrastructures. Professional activity venues are seted up for sports and exercise activities,  activity equipment equipped with  suitable for the elderly's bodies , and leisure seats are also provided.Social gathering activities use plants to form a sense of enclosure, and set up tables and chairs while taking into account the needs of activities. It is hoped that this study can play a reference role for the construction of the elderly park, so as to improve the activity experience of elderlies at the park , and enhance their sense of happiness and participation.

Leisure and entertainment activities are divided into two categories: static activities and dynamic activities. Generally, there is not much space for activities.for example, singing and reading aloud are skilled static activities that does not require large spaces. Buildings such as corridors and pavilions can be set up and the site can be isolated combined with terrain and plants, so as to avoid sound transmission and Disturbance to others. Chess, card games and calligraphy do not require high landscape, but have great requirements for activity facilities. Table, chairs and

benches are set for chess and card games. At the same time, considering that the elderly people are watching and have high aggregation, leisure seats, toilets and other infrastructures should be Placed around the area. Other researchers have pointed out that static activity can improve mental health and have retrospective potential by observing colorful scenes[12].

Exercise activities are dynamic activities, Which requires strict requirements on the site. Dancing, playing Tai chi, kicking shuttlecock, a large ball activity base requires an open, flat and large area. The ground pavement is smooth and anti-skid hard pavement, and leisure seats, shelves, toilets and other infrastructures are set around. Equipment activities need to establish a special site, sports equipment should choose a high fitness factor of the human body of professional fitness equipment, while the ground pavement should choose plastic and other soft pavement. Running and walking are generally carried out on the park road. The park road can be set as a circular plastic track to connect the main scenic spots of the park, which is convenient for the elderlies to visit and watch others' activities, Additionally, adding configure trees, shrubs and leisure seats around the track is convenient for the elderlies to rest and enjoy the scenery.

Socialising, And conducting parties are the most common social gatherings for the people in the park. Social gatherings for the elderly in the park are mostly carried out under tall trees and garden architecture sketches.However, chat and the party needs a more private space, which have a sense of enclosure and a sense of security.suci as planted around trees or shrubs.

Elderly suitability of the landscape preference in the case recreational spaces may be caused by the location,zoning type and so on,the characteristics of all kinds of leisure space are caused by it[3].

## CONCLUSION

In the context of population aging and the support of national policies, the importance of urban parks in urban life and the effect on people's health and well-being, the elderly evaluations on suitability ofpark space largely depends on landscape preferences. the comprehensive score of leisure space in Yingze Park for the elderly is 3.86. In general, the comprehensive score of each park is between 3 and 4 points, indicating that the suitability of leisure space in Taiyuan for the elderly is above average. The types of activities in which the elderly participate in the park include: recreation, exercise, and social gatherings.Elderly activity preference from high to low as follows:dancing＞Tai chi＞singing＞singing opera＞reading＞kicking shuttlecock＞bal＞scenery＞painting＞sketch＞calligraphy＞chess＞chat＞party＞personal exercise＞photography＞equipment＞running＞walking.The elderly in the park activities have relative stability. Leisure and entertainment activities are conducted in pavilions and plant gardens; exercise activities are held in open squares; social gatherings are widely conducted throughout the park.

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# A REVIEW OF SMALL URBAN GREEN SPACES STRUCTURAL COMPOSITION ON URBAN HEAT ISLAND MITIGATION

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## ABSTRACT

The urbanization led to expansion of land-use have resulted in environmental issues and necessitate mitigation or strategies on limited space in dense-city. One effective method of achieving this through small urban green spaces with the exact composition. Several studies have explored to the composition of SUGS on mitigation urban heat island effect. Firstly, a bibliometric analysis and critical review to quantitatively analyse and systematically review 27 papers published in Web of Science and Scopus database within 2017 to early 2023. A detailed critical review conducted from two main composition, in-situ and ex-situ. The result indicates that, SUGS composition focusing on several aspects of landscape feature, site, landscape patterns, land-use, surroundings area and microclimate backgrounds. However, further research is needed to compare. The outcome of this study can contribute to the body knowledge of small urban green spaces composition structures to mitigate urban heat island effect and help landscape architects, policy makers, government and planner to apply composition list and more effectively in mitigation urban heat island effect.

*Keywords : small urban green spaces, urban heat island, mitigation, cooling effect*

## INTRODUCTION

Urban area is predicted to grow by 1.2 million km2 by 2023 and nearly three-time size of all global cities in 2000, as urbanization accelerated global growth (Ren et al., 2022). By 2050, 70% of world populations will be living in urban areas (UN, 2014) and led to significant environmental problems. The expansion of urban areas related to changes in local climate and the phenomenon of temperature (Howards, 1818; Oke and Hannel, 1970; Voogt and Okel, 2003), especially in urban area are higher rather

than in suburban areas or rural areas (Peng et al., 2012; Yao et al., 2017; Park et al., 2021). These phenomena are called as urban heat island (UHI) (Oke, 1988). The phenomena have led to significant impact on outdoor thermal environment (Wang and Akbari, 2017; Li et al., 2020) and people physical and social life (Lu et al., 2022). Following the impacts of UHI, the arrangement of mitigation UHI was studied frequently, green spaces as a vital component on urban areas with ecosystem services to mitigate UHI effect (Li et al, 2020b; Dong et al, (2020); and

Guo et al, 2023) and as a tool to improving microclimate conditions (Belčáková et al, 2022). According to Kerishnan and Maruthaveeran (2021), increasing the provision of urban green spaces it could be difficult and challenging due to expansion of urban area. Nevertheless, study on green spaces mainly focussed on large public parks (Chiesura et al, 2004; Ozguner, 2011; Kothencz and Blaschke, 2017; Mak & Jim, 2019) instead of smaller urban green spaces are limited in dense cities (Peschardt et al, 2012; Macintyre et al, 2019). In this context, small spaces can become a crucial element of green spaces in urban vacant area (Zhou et al., 2022). Cities historically include wide green space are constantly changing to be more compact dense due to space limitation in metropolitan area (Armato, 2017). Large urban green space is frequently invaded or fragmented. SUGS, which area small urban green spaces, are now a significant part of open spaces in high density metropolitan settings. Currently, there is no command on definition of SUGS. It was defined in terms of the size (Lin et al, 2017). Refer to table 1 shows the definition of SUGS in previous research.

**Table 1** Definition of Small Urban Green Spaces based on previous literature review

| Year | Author/Source | Definition |
|------|---------------|------------|
| 2005 | Forsyth and Musacchio | Small Park as part of neighbourhood with recreational benefits. It limited to the potential for varied human activities and multiple natural processes. |
| 2012 | Peschardt | Small public urban green spaces (SUPGS) a public space not exceeding 5000 $m^2$ in size with vegetation at the entrance and a boundary from surrounding public space. |
| 2017 | Currie M. A | Small parks defined with three acres (1.2 hectares) or less in size and it recommended for a neighbourhood park. |
| 2010 | Baur and Tynon | Small natural park a convenient nature-based recreation opportunities and benefits on wellbeing. |
| 2016 | Annerstedt | Public urban green space with an area below 1 ha and 300 m maximum linear distance to the boundary. |
| 2022 | Chiesi and Costa | Small green space with formal qualities of size smaller than 5600 m2 and vegetation cover at least half of the total area, entrance or distinguishable boundaries from surroundings. |
| 2021 | Wu et al | Urban public green space larger than 0.09 ha and less than 3.5 ha including mini urban parks and street and roadside greenways but exclude single isolated tree or single row street trees. |

The purpose of this study is to conduct a systematic literature review on small urban green spaces (SUGS), to provide comprehensive overview of structural composition on SUGS by reviewed research published between 2017-2023 concerning on SUGS and critically assessing the research outputs to mitigate UHI effect. This will be achieved through the following questions: (1) what are variable measurements on SUGS to mitigate urban heat island? (2) where the gap knowledge on structural composition of SUGS? Section 2 outlines the methodology used to search the literature, while section 3 provides a comprehensive overview of variable measurement on SUGS. Section 4 will offer a detailed critical review of SUGS research from variable measurement of structural composition to mitigate UHI effect. Furthermore, in section 5, author offer a discussion on future research and provide a recommendation based on the findings. Finally, section 6, presents the conclusion of this study. This study highlights the importance of composition structural of SUGS on mitigation UHI effect and providing researchers with knowledge to promote their general acceptance. Additionally, it can assist urban planners, practitioners, policymakers, and government in application of SUGS to create more resilient cities in the future.

## MATERIALS AND METHODS

To address research questions above, a literature search was conducted in Web of Science (WoS) and Scopus between June

and July of 2023. Following Moher et al. (2009), the authors developed a search string based in Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) it can be refer on Figure 1. The timespan is from 2017- early 2023 and includes 850 on Scopus and 1,104 on WoS publications. It gathered significant research on SUGS to mitigate UHI effect, including relevant theoretical and systematically sorted out the titles, abstracts, and identify the most common keywords related. However, researchers use related keywords such as mini park and small neighbourhood park to explore the topic. The inclusive query for publications related to the topics 'small urban green spaces', 'mini park', 'small green spaces', 'small neighbourhood park' and 'small park'. The source categories of WoS and Scopus database was published in English language. Authors eliminated weakly relevant publication by carefully reviewing tittle, keywords and abstracts, resulting in the identification of 154 relevant publications in WoS and Scopus database. All studies meeting criteria include above and exclusion criteria of mitigation UHI effect and small urban green spaces and unpublished data of any from including conference proceedings, case reports, and dissertations. Ultimately, authors deleted 16 duplicate items from the two databases and identified a total of 40 publications. This paper utilized a tool of Systematic Appraisal of Quality in Observational research (SAQOR) by Down and Black (1998) and Wells et al (2003) to analyse the quality of selected papers to fulfil the gap. As the number of final papers was low, this study conducted qualitatively with total 27 publications.

**Figure 1** PRISMA Framework
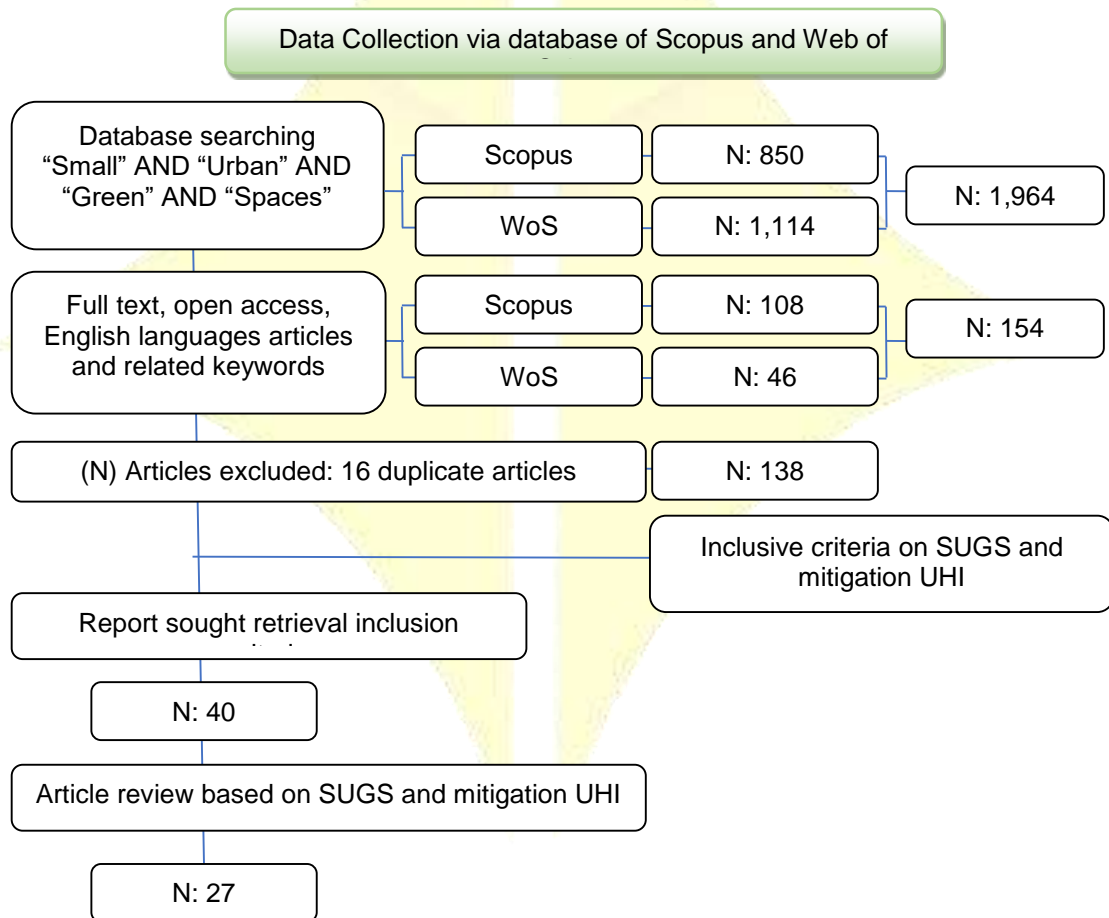


This paper utilized the Citespace 6.2 tool to analyse the key characteristics of

research on SUGS, based the co-keywords network and dynamic changes in the field. Citespace to analyse the cooperation keywords' word frequency and used to visualize the research universe in the field. The resulting help to distinct research directions and exposed the connection in overall structure. Therefore, the paper conducted a bibliometric analysis to review on the overall picture of SUGS on mitigate UHI effect studies.

## THE OVERALL PICTURE OF SUGS ON MITIGATE UHI EFFECT

The number of annual publications can reflect the speed of development, trends and level of attention given by researcher on SUGS focusing on mitigation UHI effect. After using keyword co-occurrence function with 283 nodes and 1108 connections, leading to a network density of 0.0278 (Figure 2). Author analysis

**Figure 2** Co-occurance keyword of SUGS studies



revealed the top 20 frequently research keywords related to SUGS (table 2) with centrality 0.1 include 'greenspace' (0.21), 'atmospheric temperature' (0.34), 'heat island' (0.12), and 'vegetation' (0.26). Based on the high frequency and centrality, it would be safe to assume that 'cooling', 'greenspace', 'urban heat island', 'atmospheric temperature', 'heat island' and 'urban green space' as fundamental on this study field.

Table 2 Frequently research keywords related to SUGS studies

| Number | Count | Centrality | Year | Keywords |
|---|---|---|---|---|
| 1 | 14 | 0.03 | 2018 | Cooling |
| 2 | 10 | 0.21 | 2017 | Greenspace |
| 3 | 9 | 0.01 | 2017 | Urban Heat Island |
| 4 | 9 | 0.34 | 2017 | Atmospheric Temperature |
| 5 | 8 | 0.08 | 2017 | Urban Green Spaces |
| 6 | 8 | 0.12 | 2017 | Heat Island |
| 7 | 7 | 0.02 | 2017 | Urban Planning |
| 8 | 7 | 0.02 | 2017 | Urban Area |
| 9 | 6 | 0.26 | 2017 | Vegetation |
| 10 | 6 | 0.29 | 2017 | Cooling Effect |
| 11 | 6 | 0.47 | 2018 | China |
| 12 | 5 | 0.00 | 2020 | Remote Sensing |
| 13 | 4 | 0.00 | 2019 | Landforms |
| 14 | 4 | 0.00 | 2019 | Land Surface Temperature |
| 15 | 4 | 0.00 | 2022 | Green Spaces |
| 16 | 3 | 0.00 | 2020 | Urban Greening |
| 17 | 3 | 0.02 | 2018 | Urban Green Spaces |
| 18 | 3 | 0.07 | 2019 | Surface Temperature |
| 19 | 3 | 0.06 | 2017 | Microclimate |
| 20 | 3 | 0.01 | 2019 | Landsat |

## RESULT AND DISCUSSION

Small urban green areas typically combine different design and function by establishing important characteristics into useful attributes (Fatiah et al, 2021 and Currie M.A, 2019). In summary, the attributes influencing composition structural can be categorized into two aspects, namely by in-situ and ex-situ.

Melas et al (2021) and Li et al (2020) found that vegetated site shows a stronger cool island pattern compared to non-vegetated it was calculated by air temperature data and tree cover types were denser and increase the amount of evapotranspiration cooling by create local microclimate and maintain the humidity (Yan et al, 2021). Composition of vegetation types, shrub,

grass, and tree also affected the land surface temperature and effect the cooling effect (Wu et al, 2021). Vegetation types on urban green spaces, trees can effectively prevent direct sunlight with significant cooling effect is higher rather than shrubs and climbing vegetation have the lowest cooling effect (Shi et al, 2021). A structure of vegetation composition can have a significant impact on mitigating UHI (Rakoto et al, 2021). Furthermore, a study by Ma et al (2022) and Guo et al (2023),

an optimization layout of vegetation which excessive and irrational planting cannot produce an effective improvement in thermal environment based on weather conditions. Cluster tree could reduce temperature 0.96∘C-1.59∘C but a single tree can reduce from 0.77∘C to 0.88∘C (Amani-Beni et al, 2018). However, a thinner layer of soil water can affect the evapotranspiration and it should be maintained or maximize it by additional irrigation (Yan et al, 2023).

**Table 3** Composition of SUGS on mitigate UHI effect

| Composition | | Sub-composition | Studies |
|---|---|---|---|
| In-Situ | Landscape feature | Vegetation (tree, shrub, grass), Soil | Melas et al (2021), Wu et al (2021), Yan et al (2021), Rakoto et al (2021), Amani-Beni (2018), Yan et al (2023) |
| | Site | Size, layout | Ma et al (2022), Guo et al (2023) |
| | | | |
| Ex-Situ | Landscape pattern | Buffer and distance, shape (Plue morphology), | Wu et al (2021), Xiao et al (2020), Yu et al (2018), Park et al (2017), Xu and Zhao (2023), Shah et al (2021) |
| | Land-Use | Settlement | Wu et al (2021), Aram et al (2019), Anggrahita et al (2020) |
| | Surrounding | Building height, waterbody, hydrological connectivity | Ma et al (2022), Yan et al (2021), Balany et al (2022), Wu et al (2021b), Omar et al (2018) |
| | Microclimate | Air temperature | Melas et al (2021), Li et al (2020) |
| | | Wind direction and speed | Lu et al (2017), Yu et al (2018) |
| | | Humidity | Li et al (2020) |

The ex-situ composition factors followed by characteristics of the physical and environment surrounding of SUGS. The surrounding SUGS influence cooling effect for the reduction of land surface temperature (Yan et al, 2021). Additionally, a higher capacity of waterbody mainly associated with evaporation stronger than vegetation or impervious surface and it would consider cooling effect at daytime (Yan et al, 2021 and Balany et al, 2022). The settlement of SUGS can be considered, study by Anggrahita et al (2020), green narrow alleys as green intervention and sites with average temperature 2∘C and 5% higher than non-green narrow alleys of humidity. Therefore, Yu et al (2018) and Xiao at al (2020), interconnection of cooling intensity with characteristic of SUGS such as size

and complex shape can be optimized and effect the cooling intensity due to indicate a less complicated boundary. Previous study by Yu et al (2018) mentioned a less than 10 ha SUGS with a compact or irregularly shape can provide greater temperature reductions and provide cooling effect distance (Shah et al, 2021). Study by Park et al (2017), a SUGS with complex or mixed polygonal shape had a significant cooling effect with reducing air temperature by 3.5∘C at 1.500m². Demonstrated the size of the patch has a considerable impact on the cooling ability of SUGS, with different sized green space patches having varying results in terms of controlling temperature within 0.67∘C and 4.04∘C at 0.1-16 ha SUGS (Xu and Zhao, 2023). A SUGS study by Xiao et al (2018) indicated instability of microclimate at

small size park and it might influence by external environment such as built environment or presence of water bodies with wind speed. Previous study by Du et al (2016) and Xue et al (2019) mentioned about combination of blue-green space can improve cooling intensity while according to Wu et al (2021b) at the wetland area vegetation surrounding can only expand the cooling on large scale. Cooling impact by water bodies can reduce temperature from 1 until 1.03°C and water bodies as important sub-composition of SUGS as well as vegetation green space in lowering temperature in urban areas (Kemarau & Eboy, 2020). Furthermore, a waterbody as a passive cooling instrument and it should be optimized with basic vegetation requirement and unblockage wind direction. Furthermore, according to Yu et al (2018), wind speed has a high positive correlation with cooling effect, contributes to vegetations evapotranspiration process, lowers leaf temperature and aids in disseminating the cooling effect. According to research by Lu et al. (2017), a higher wind speed would geographically constrain the park's cooling impact and result in a lower park cooling island intensity. However, some of studies emphasize different sample and climatic backgrounds may also affect result of studies (Ren et al, 2013; Yang et al, 2017).

## CONCLUSION

Small urban green spaces an efficient mitigation urban heat island effect in high density urban areas. This study conducted a bibliometric analysis of 26 papers published in WoS and Scopus databases between 2017 to early 2023, aiming to understand the composition structural of SUGS on mitigation UHI effect research. Furthermore, it provides a detailed critical review of in-situ and ex-situ composition obtained from literature review and bibliometric analysis. The main findings of this systematic literature review are as follows:
Firstly, a network density of SUGS study was 0.0278 and it have frequently keywords related with 0.1 centrality such as 'greenspace' (0.21), 'atmospheric temperature' (0.34), 'heat island' (0.12), and 'vegetation' (0.26). Secondly, the composition of SUGS to mitigate UHI effect based on in-situ and ex-situ composition. However, the mechanism of their composition warrants further investigation. This review can serve as a roadmap for researchers who are interested in studying small urban green spaces as tool mitigation urban heat island effect in the future. It can also assist landscape architect, government, policy makers, planners to broader application of small urban green spaces to mitigate urban heat island effect.

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# THE TRENDS OF HISTORIC URBAN LANDSCAPE APPROACH IN CHINA: A SYSTEMATIC REVIEW

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## ABSTRACT

China's rapid urbanization growth during the past decades which has highly promoted the development of cities has induced various challenges for the historical area. The problem of historical area declines of quite many historic cities which are suffering deficiency of protection in turn challenges the conservation of historic cities in China. Historic cities are frequent targeted for the rapid transition to urbanization that are often accompanied by the alteration of a historic city landscape. To maintain the unique character of the ancient city without the impact of urbanization, the authors have to find a way to appraise the character of the Historic city and protect the distinctive space, to keep the cultural landscape of the historic city. Hence, this paper tracks the genesis of a landscape approach to heritage conservation and then presents a systematic review of the literature on the HUL. The applied methodology is based on the literature review of publications composed of books, book chapters, peer-reviewed articles, conference papers, theses, and reviews. More than 300 publications from 2010 to 2023 were analyzed. We noticed a lack of sound assessment based on the Historic Urban Landscape (HUL) that would enable identifying and describing the variation in the character of the historical landscape. Therefore, the objective is to understand the current research situation and trend of the HUL approach in Chinese scholars and Chinese historic cities by analyzing the publications on the HUL approach related to China. The expected outcome is to find a rational approach to assessing historic urban landscapes through a system review. To provide an impetus for the research and practice of the HUL approach.

*Keywords : Hitoric Urban Landscape 1, Historic city 2, China 3, Framework4*

## INTRODUCTION

The origin and evolution of HUL

The concept of "Historic Urban Landscape (HUL)" appeared for the first time in the Vienna Memorandum(UNESCO, 2005), not as a type of heritage, but as a methodology for conservation, management, and planning of urban heritage (W. Zhang & Han, 2017). In 2011, UNESCO adopt the Recommendation on the Historic Urban Landscape, which refers to urban heritage is for humanity as a social, cultural, and economic asset, defined by a historic layering of values that

have been produced by successive and existing cultures and an accumulation of traditions and experiences, recognized as such in their diversity (UNESCO, 2011). The HUL approach has established an integrated framework to assess and manage the constituent elements of urban heritage from different perspectives. "The historic urban landscape approach explained" was issued in 2013, to better apply the HUL methodology to the conservation and management of historic cities.

In 2015, the report "Report on the Implementation by Member States of the 2011 Recommendation on the Historic Urban Landscape, including a Glossary of Definitions" submit that it is necessary to connect the HUL approach to the 2030 agenda for sustainable development (UNESCO, 2015). By 2017, to fulfill Goal 11 of the 2030 agenda for sustainable development-Sustainable Cities and Communities, the HUL approach is employed to improve urban planning and management (UNESCO, 2017). HUL approach has become a widely acknowledged theory, which supports public and private actions aimed at preserving and enhancing the quality of the human environment and also can maintain urban sustainable development.

In the 2016 Global Report on Culture and Sustainable Urban Development, HUL was cited as a theoretical basis to make clear that urban heritage conservation needs to move beyond monument-based, full protection and government-financed approach, to ensure that urban heritage is not a liability but an asset for cities and their communities (UNESCO, 2016). The HUL approach provides a holistic sustainable development framework for identification, assessment, conservation, and management of historic urban landscapes (UNESCO, 2011). This framework provides a good way of reflecting on the current issues of urbanization, the quality of the living environment, heritage preservation, and urban management in the context of sustainable urban development.

In 2019, the first consolidated report (UNESCO, 2019) highlights the importance of integrating the Historic Urban Landscape approach with the 2030 Agenda for Sustainable Development, particularly the Goal 11 on inclusive and sustainable cities, the New Urban Agenda, and the 2030 Agenda "The Africa we want" to address current global challenges, including urbanization and to foster inclusive and sustainable local development. The implementation of the HUL approach contributes to the preservation of natural and cultural heritage, protects the various resources available, and ensures the sustainable development of the cities.

The second consolidated report (UNESCO, 2022) re-emphasizes the approach of the 2011 Recommendation is aligned with the vision outlined in the UN-Habitat New Urban Agenda2 for a more sustainable future and closely intersects with the economic, social, and environmental pillars of the 2030 Agenda for Sustainable Development3, and particularly with SDG 11 which focuses on sustainable cities and communities (UNESCO, 2022). The third consolidated report (UNESCO, 2023) indicates that the Recommendation is more germane today than ever before, as cities and their heritage continue to face a complex set of global challenges and seek sustainability, inclusiveness, and resilience. It is important the implementation of 2011 Recommendation as an urgent and necessary tool for resolving the conflicting demands of heritage conservation and urban development for more sustainable cities, including cities with and without properties inscribed on the World Heritage List. As can be seen from the three consecutive synthesized reports, the HUL Recommendation is increasingly valued for its excellent practical significance in the global sustainable development process.

The definition of HUL

In the HUL Recommendation, the historic urban landscape is the urban area understood as the result of a historic

layering of cultural and natural values and attributes, extending beyond the notion of "historic center" or "ensemble" to include the broader urban context and its geographical setting (UNESCO, 2011). The understanding of the concept of HUL has been consistent across the board (Van Oers et al., 2012). Discovering the connections between urban heritages that were originally protected in isolation from each other and analyzing, evaluating, and conserving them as a whole. It brings to the fore the relevance of historic urban landscapes that would otherwise not be apparent. Then, the key steps for the dynamic identification, assessment, conservation, and management of historic urban landscapes are also identified (Rey-Pérez & Pereira Roders, 2020).

HUL in China

Currently, China has made milestones in the HUL approach in theoretical and practical research. Theoretically, Van (Van Oers et al., 2012) suggested that the Recommendation could be incorporated into the country's legal and institutional frameworks to assist in the protection of relevant urban development control objectives. Liu (Y. Liu & Wang, 2017) argue that the HUL approach should be used to realize that all land should retain a record of its natural and cultural evolution, to recreate a human-nature connection and restore a continuity from the past to the future. Li (J. Li et al., 2022) argue that the HUL approach should be localized and practiced in China to further enhance the vitality and sustainability of Chinese urban space while maintaining local cultural continuity and sustainable conservation and use of heritage resources. In terms of practice, Li (H. Li et al., 2017) takes the ancient city of Xi'an as an example, establishes a gene pool of urban historical and cultural resources through the perspective of HUL, and proposes a strategy of Xi'an's urban historical landscape living conservation system based on this. Through the study of Lhasa's urban historic landscape, Xiao (Xiao & Cao, 2019) found that the urban landscape pattern is closely related to

people's religious beliefs and assessed the four landscape vectors (including urban pattern, cluster renewal, place revitalization and landmark revitalization), to grasp the impacts of the relevant actions on the historic landscape in the process of urban development, to guide the practice of urban construction and conservation management.

The necessity of the research

A review of the literature on HUL methods in China over the past decade reveals that most of the research results have been published in Chinese journals only. Those who are not able to read Chinese, do not have a good understanding of the research results of HUL methods in China. The purpose of this study is to present a systematic review to analyze the HUL method research literature related to China, in an attempt to explain the research results of Chinese researchers and Chinese cases using the HUL method to more researchers who cannot read Chinese. Making these research results can be the driving force for the continuous improvement of the HUL approach.

## METHODOLOGY

This paper tracks the genesis of a landscape approach to heritage conservation and then presents a systematic review of the literature on the HUL. The applied methodology is based on a systematic review of peer-reviewed publications, published in databases such as ISI Web of Science©(WoS), Scopus© and China National Knowledge Infrastructure (CNKI), published from 2010 to 2023, such as journals, book chapters, and conference papers. About 281 potential papers from CNKI, 134 from WoS, and 40 from Scopus were identified by searching for "China" and "Historic Urban Landscape" in titles, abstracts, and keywords.

By reading the abstracts, we exclude those erroneous papers that have nothing to do with the search keywords. Finally, 161 Chinese journals, 82 dissertations,

and 30 conference papers were obtained. Among the dissertations and conference papers, there are also cases in which the contents are duplicated or similar to those of the journal papers, so this study is conducted in 161 Chinese journals. English dissertations on the screening results because of the predominance of journals, then select all types for this study. Among them, there are 30 papers all of which appear in both WoS and Scopus. Thus, it is 144 English papers. The analysis and conclusions of this study were carried out with these 305 papers.

## RESULT

Analysis of the Number of Publications

By analyzing 161 Chinese journals and 144 Chinese-related English papers, 100 Chinese and 29 Chinese-related English papers were filtered out from which the HUL approach was applied. From the HUL approach, 56 pieces of Chinese journals  (accounting for 56%) and 25 pieces of English papers (accounting for 86%) were analyzed to conduct a case study. The literature review studies were conducted in 13 Chinese (13%) and 3 English (10%). This show that more than half of the HUL methodology studies used case study.

From 2005, when HUL was proposed, to 2011, the Recommendation was formally published to clarify the application of HUL methodology. Until now, HUL has been recognized by various countries and organizations, and gradually applied to national policies and systems. All of this could not have been achieved without the dedication of the relevant researchers over the past decade or so. In Ray's (Rey-Pérez & Pereira Roders, 2020) study, it was learned that publications citing the HUL approach increased substantially between 2008 and 2018(Figure 1). This is generally consistent with the results of this study's analysis of Chinese journals and Chinese-related English articles. Especially after 2015, the number of papers increased very significantly, reaching a peak around 2017, and the Chinese journals and

Chinese-related English articles also showed the same growth trend in this period. After that, there is a gradual decline until around 2019(Figure 2).



**Figure 1** Number of papers, according to their year of publication, between 2008-2019. Source: (Rey-Pérez & Pereira Roders, 2020)
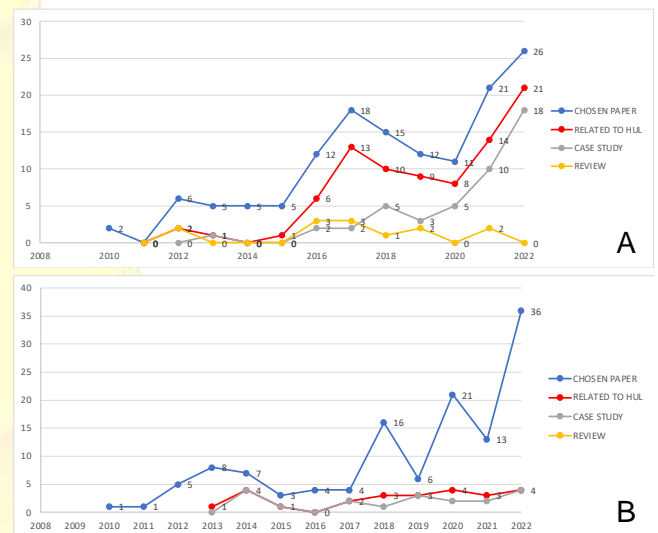


**Figure 2** Number of papers, according to their year of publication in Chinese (A) and Chinese-related English (B), between 2010-2022. Source: Authors

Similarly, the number of papers, both in Ray's study and in this study, production falls around 2019. Interestingly, it is found in this study that the number of published papers shows another rapid growth trend from 2020 to 2022. However, the difference is that the growth trend of case-related studies in Chinese journals is very obvious, but the English papers show a flat trend. This phenomenon indicates that the results are not as obvious as those of Chinese literature in terms of Chinese-related English literature publications. The amount of research is published in Chinese papers.

## 3.2. Analysis of the content of Papers Published

In 2013, UNESCO published the brochure "New Life for historic cities: The historic urban landscape approach explained" (UNESCO, 2013), which introduces the Recommendation on the Historic Urban Landscape, and how to apply the Historic Urban Landscape approach in the local context. And the six critical steps recommended for the implementation of this approach. Due to the continuous development of the HUL approach, the depth of the research has not been consistent. Therefore, most of the studies remain in the first step. To fulfill the HUL approach, it is necessary to carry out a full assessment of the historic urban landscape. And the first step is to undertake a full assessment of the city's natural, cultural, and human resources. At this point, Some assessment systems that can be used for the evaluation of historic urban landscapes are published, such as HLC(Rouse, 2008), HTC(Walsh, 2012), and LCA(Lu et al., 2022). These assessment approaches are also expressed and applied in the papers of this study. Moreover, other assessment approaches also appeared. To comprehensively analyze the research situation of HUL in China, the findings of the research results based on the HUL approach in the papers were categorized concerning the specific content of the research results, and the results were obtained as shown in Figure 3.

Comprehensively analyzing the content of the papers, the research papers were categorized in terms of spatial pattern, landscape characteristics, landscape value, the evolutionary process, landscape elements, urban form, landmark style, digitization, landscape classification, and many other aspects. Due to the small number of Chinese-related English papers, there are only 29 papers, which is not enough to obtain effective data. Therefore, the Chinese journals and Chinese-related English papers were gathered together to analyze

the specific content of the research results, and 129 papers were taken as a whole for the study. Therefore, the Chinese journals and Chinese-related English papers were gathered together to analyze the specific content of the research results, and 129 papers were taken as a whole for the study.

As shown in the figure, most of the research on the HUL approach focuses on the spatial pattern, landscape characteristics, landscape value, the evolutionary process, and composition of landscape elements, and the total number of them accounts for 63% of all the papers (81 papers). Among them, the spatial pattern has the highest number of studies and is significantly more than other research directions, accounting for 30% of the total. The number of papers on landscape characteristics, landscape value, evolutionary processes, and the four classifications of landscape elements is similar, with the number of papers around 20. Other journals have less research content, accounting for a small percentage.
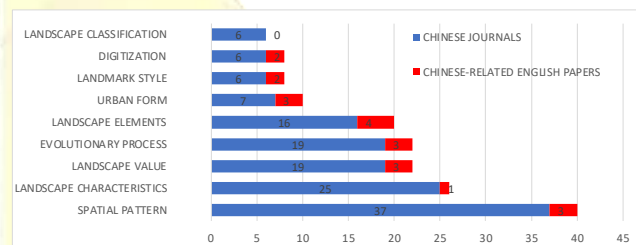


**Figure 3** Number of papers, Categorization based on the content of the paper, between 2010-2023. Source: Authors

On the whole, the research on spatial patterns is the most numerous and significantly more than other research directions, and the research on spatial patterns is also often conducted together with the urban evolution process (Xiao et al., 2018). In the study of spatial patterns, more researchers use the theory of urban morphology, such as the former French Concession in Tianjin (Yang & Zheng, 2018) and Hohhot (Yan et al., 2022). Therefore, although the spatial pattern, the evolutionary process, and urban

morphology are studied separately, they are all researched from the two-dimensional space of the city. Some researchers focus on landscape characteristics (T. Li & Yang, 2023; Zhao et al., 2023), landscape values (Xiao & Cao, 2019; T. Li & Yang, 2023), and landscape elements (H. Li & Zhang, 2019; H. Zhang & Zhao, 2022). These three parts of the study, although different, are essentially analyzed from the composition of the city's historical landscape to get the distinctive and worthy protection landscape of the historic cities.

## DISCUSSION

The development trend of research on HUL methods in China

Through the analysis, it is concluded that the percentage of papers published using the HUL approach is relatively high, indicating that most researchers consider the HUL approach to be a well-established research theory in the study of historical cities (W. Zhang, 2018). Many Chinese researchers have applied this approach to the study of historic city conservation in China (Zhu & Zhang, 2013; NI & Xiang, 2016; Wang & Gu, 2020; Han et al., 2022).

When the Recommendation was released, the new topic of the HUL approach become the focus of attention, and the number of related literatures published increased year by year, showing a favorable development trend. At the same time, the review literature on the HUL approach has also contributed to the study of the HUL approach (Zheng & Yang, 2012; Van Oers & Pereira Roders, 2013). This indicates that the HUL approach received wide recognition at the beginning.

The reason why the number of papers published showed a rapid increase after 2015, as already pointed out in the study by Ray (Rey-Pérez & Pereira Roders, 2020), is because of Badarin's book (Bandarin & Van Oers, 2014). The research on the HUL approach has received more attention. The release of this book led to the research on the HUL approach. However,

without the guidance of UNESCO, the HUL approach would have been like the trend in the number of publications, which peaked around 2018 and then declined and leveled off.

UNESCO has published three comprehensive reports on the HUL approach in 2019, 2022, and 2023. The publication of these three reports takes the HUL approach beyond the study of historic cities and links it to the 2023 Agenda for Sustainable Development and the New Urban Agenda. The HUL approach is now no longer a single recommendation, but one that can contribute to the global sustainable development process and provide a theoretical basis for future urban sustainable development.

HUL approach in China

In addition to HLC, HTC, and LCA, which are evaluation theories discovered by European researchers, Chinese research on the HUL approach also has unique insights. Xiao's (Xiao et al., 2018) study takes the layered nature of historical and cultural landscapes in the HUL approach as the basis for the analysis of the spatiotemporal evolution process of different types of historical cities. Then the changing law of the spatial pattern characteristics of the cities' historical landscape is refined. Xiao then competed to study the Ü-Tsang by applying the layered nature of historical and cultural landscapes (Xiao & Cao, 2019).

Cao (Cao & Li, 2019) proposed an exploration of historic town conservation based on Diachrony and Synchronism analysis. This approach discovers and rationalizes the core values of ancient cities through the excavation of their historical layers of Diachrony in the time dimension. On this basis, it starts from the spatial dimension to identify and refine its specific landscape characteristics. Thus, relying on time and location in space, we can realize the comprehensive knowledge of historical cities and explore more scientific and effective protection approaches. Zhu's (Zhu, 2021) study of

the Hanyang Iron Works Pilot Zone in Wuhan and Tian's (Tian et al., 2022) study of Guilin applies this theory. Both theories show the " layers " in the HUL approach very well.

When the papers in this study analyzed the characteristics and values of urban historic landscapes, more papers focused on the research through the spatial pattern (Xiao et al., 2017), architecture (Xu & Zhang, 2021; Zhong & Li, 2021), and infrastructure (M. Zhang et al., 2016) of the city. These studies focus on the top of the tangible cultural heritage. Digital technology will also be used to provide a better way to use the HUL approach (He, 2022; Kang, 2020), such as the ancient city of Ganzhou City (T. Li, 2019), the Imperial City of Shengjing in Shenyang (Lin, 2021), and the ancient town of Zhongshanpu (D. Zhang, 2023). However, the research on intangible cultural heritage and local cognition is slightly insufficient. This is consistent with the findings of Ray (Rey-Pérez & Pereira Roders, 2020). This suggests that research on HUL, both in China and elsewhere, has focused more on the material that currently exists, and there is still a lack of research on the intangible urban historical and cultural landscapes.

The ancient Chinese book "Kao gong Ji", which is a classic work on science and technology in Ancient China, recorded: " The craftsmen built the city, which was nine miles on a side and had three gates on each side. The city had 9 horizontal roads and 9 vertical roads ...". This is the earliest system of Chinese cities, also be found from currently existing ancient urban construction. With the change of time, the layout of each ancient city gradually had its own unique changes (W. Liu & Huo, 2019). And then, the unique changes of the ancient cities that reflect the "laying" in the HUL approach. Therefore, on the research of Chinese ancient cities, the spatial pattern is a very important research part. The importance of the spatial pattern of ancient cities in conducting urban heritage research can also be seen in Figure 3. This indicates that the urban spatial pattern was an important research element when the HUL approach was used to conduct the Chinese urban heritage. It is the change of urban spatial pattern over time that reflects the unique landscape characteristic of the ancient city, which in turn explains the value of the ancient urban landscape.

Building (Ramírez Eudave & Ferreira, 2021) and infrastructure (Zivdar & Karimian, 2020) are the multiple agents that conform the urban entity. The study of building is necessary, as it can provide information about many other tangible and intangible heritage, such as historical events of different periods, building techniques and so on. Therefore, building is an important part of urban heritage. And Zivdar (Zivdar & Karimian, 2020) argues that important infrastructures should be included in a general framework of urban conservation. Therefore, if there are important infrastructures in an antient city, the infrastructure should also be studied as urban heritage. Buildings and infrastructures become urban heritage in antient cities when they are unique enough to become landscape characteristic and own landscape value. Accordingly, buildings and infrastructures are the basic elements of the urban spatial pattern. It is not difficult to understand why when the HUL approach is used in China, the research mainly focuses on the spatial pattern of the antient city. It is because the spatial pattern of ancient cities in China is the basis for the generation of historical urban landscapes. The study of landscape characteristics and landscape value is the embodiment of the spatial pattern of ancient cities in the HUL approach. The study of the evolution process of the ancient city is the study of "historical laying" in the HUL approach. Most of the landscape elements include the spatial pattern, the evolution process, the building, and the infrastructure, etc., in order to show the historical urban landscape of the ancient city in China.

A framework of Historic Urban Landscapes in China

The research of HUL approach in China started late, but it has been synchronized with international progress. The analysis of this paper shows that the application of the HUL approach is mostly based on the spatial pattern of the ancient city to carry out the research on the landscape characteristics and landscape value of the ancient city in China. The landscape characteristic and landscape value of the ancient city is shown through the evolution of the ancient city space and the composition of landscape elements. Among them, the composition of landscape elements mostly includes spatial pattern, evolutionary process, architecture, infrastructure and so on. It is inferred that China's ancient cities will be studied according to Figure 4 when applying the HUL approach.
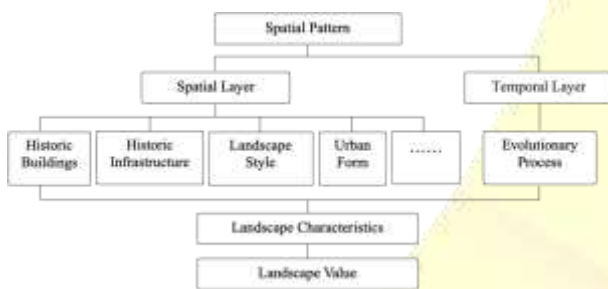


**Figure 4** A framework of Historic Urban Landscapes in China. Source: Authors.

## CONCLUSION

Due to the differences in cultural background and language, China is not fully known to the world in HUL methodology research. Most of the communication still needs the help of international organizations and some foreigners who are devoted to Chinese HUL research, such as UNESCO and Van Oers. Although Chinese researchers can also publish in English journals, this is still difficult for Chinese researchers. This is also the reason why there is significantly less foreign literature on the application of HUL methods in China.

However, it can be seen from this study that although there are certain obstacles, they do not affect the research and development of the HUL approach in China. In the development of the HUL

approach, the pace of China and the international community is the same. Chinese scholars have established their theories and found their ways by understanding the HUL approach and combining it with the unique characteristics of China's historical ancient cities. At present, the conclusions obtain from Chinese studies are relatively more suitable for Chinese research, and it is believed that shortly, these theories and methods can be more inclusive, more easily understood by people with other cultures, and more frequently applied to other places outside of China.

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# THE RESILIENCE OF *'Linpan'* CULTURAL LANDSCAPE: A NARRATIVE REVIEW OF BACKGROUND, ISSUES AND CHALLENGES

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## ABSTRACT

*'Linpan'* (林盘) is a traditional rural settlement in Chengdu, the capital of Southwest China's Sichuan Province. It is a traditional and historical settlement that is rich in farming civilization and cultural values. *'Linpan'* is a traditional rural community that integrates production, life, and culture. Likewise, it is known to be the farming civilization of China. However, the rapid development and acceleration of industrialization and urbanization have led to the gradual disappearance of 'Linpan''s traditional settlement and cultural landscape values. Hence, this paper aimed to explore and review the background, issues and challenges of resilience of *'Linpan'* traditional settlement systematically in order to identify the landscape planning and management direction that can sustain the *'Linpan'* as well as its cultural significance in the local development context. The sources of review on *'Linpan'* settlement and community included 120 journals work published in Scopus, Web of Science, Science Direct, and other secondary data done between 1973 and till date. The paper started the review from background of *'Linpan'* including its history, definition, and spatial layout pattern. Then the paper discussed issues faced by 'Linpan', followed by the analysis of existing research results on 'Linpan', cultural landscapes, and resilience studies in China through a narrative approach. Conclusion, the paper suggested adopting an adaptive planning and management framework to support the resilience of the 'Linpan' cultural landscape in China.

*Keywords: 'Linpan' 1, Resilience 2, Cultural landscape 3*

## INTRODUCTION

Globalization and modernization have become a threat to the uniqueness of indigenous cultural landscapes (Antrop, 2005). In China, research carried out on cultural landscapes is relatively new, which only started around the 1990s and was initiated by Western cultural landscape concepts. Compared to the relatively developed cultural landscape studies in the West, China cultural landscape still have a big room to be explored (Bender et al., 2005; Lee, 2007; Palang et al., 2011; Ruiz and Domon, 2012; Sevenant and Antrop, 2007). Nevertheless, there are many remaining cultural landscapes so far being neglected

in conservation and management, and also lacks of consideration in their resiliency and sustainability in national development.

For example, 'Linpan' (林盘), is basically known as a traditional rural settlement in Chengdu, the capital of Southwest China's Sichuan Province. It is one of the most representative rural landscapes in China. The unique feature of 'Linpan' is its specific spatial distribution between humans and nature, as well as the combination of lifestyle and spirit of Chengdu farmers in the old times

According to Lu (1712), 'Linpan' is distributed on a family basis, in which each family house is backed by bamboo woodlands. The other families, which can be regarded as neighbors, usually stayed half a mile or one mile away from each other. The spatial structure of 'Linpan' includes a farmhouse, bamboo woodland, and farmland. With the evolution of history, the settlement was later formed in either concentrated or dispersed forms, reflecting the cultural characteristics of Chengdu people and Chengdu rural living spaces. However, with the rapid development of urbanization, the total amount of 'Linpan' settlement in Chengdu decreases rapidly in recent decades. Many 'Linpan' farmlands were destroyed by urban land expansion. Most of the local traditional folk cultures have also disappeared with the ruins of 'Linpan'; The widening gap in living quality between urban and rural areas finally led to the decline of the ''Linpan'' population.

Therefore, in order to sustain the 'Linpan' traditional settlement and the related cultures and heritages, this paper aimed to review the existing works of literature on 'Linpan' studies and also to examine the current issues and challenges faced by the settlement in terms of resilience.

## REVIEW OF 'Linpan' BACKGROUND

**History**

'Linpan' presents the ancient and long-standing farming culture of China. It began in the Qin Dynasty, more than 2,000 years ago. Because of the warm and humid climate as well as the rich water sources (rivers) in Chengdu Plain, the resources are abundant and various. With the progress of ancient farming development, more and more food sources were cultivated and available for people. Therefore, many refugees were attracted to settle here during the war, and more and more villages were built. During this period, as primitive 'Linpan', woodlands and fields were built along with houses as fences to protect them from wildlife and to protect the land from erosion during floods (Sun, 2019). Then, it was gradually completed with systematic production spaces and living spaces. According to classical scholar (Zuo, B.C 317), in the Han dynasty, more and more 'Linpan' appeared in Chengdu Plain. Most 'Linpan' residents during this period had affluent life.

In 316 BC, after the state of Qin destroyed the state of Chu, the king of Qin established Chengdu. In this period, the government of Qin encouraged people who lived in other provinces of China to migrate to Chengdu Plain. At the same time, the political and economic recovery during the Tang dynasty led to the economic and cultural development of Chengdu Plain. The revival of the Chengdu Plain attracted a large number of people who lived in other provinces of China to come to Chengdu to do business and settle down. The advanced techniques of agricultural production and experiences during that period promoted the development of different cultures in Chengdu Plain. In the late Qing dynasty, many ''Linpan'' was damaged by war. The evolution of 'Linpan' in different old China dynasties was summarized in Figure 1.1. In the era of new China, ''Linpan'' now is facing threats due to the process of modern urbanization.
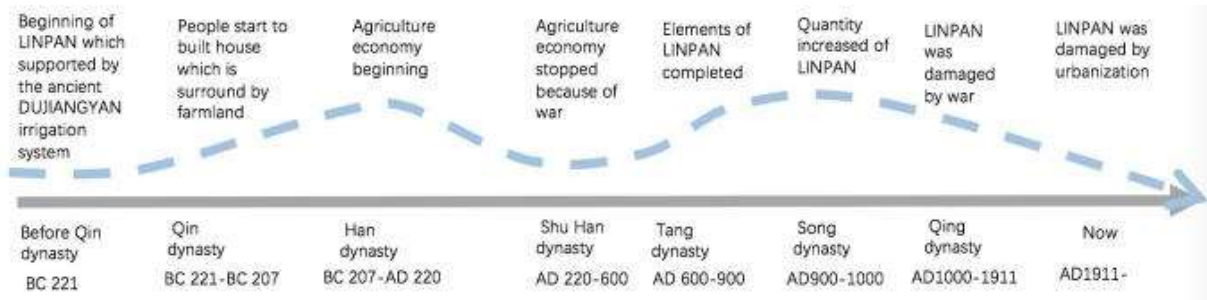
Figure 1.1: The historical evolution of the 'Linpan'

## Definition

'Linpan' is a physical outcome of typical Chinese traditional farming culture (Zhang, 2019). Chinese scholars have defined the concept of 'Linpan' from different perspectives. Duan (2008) defined it as based on setting layout, in which there is a farmhouse inside a woodland of bamboo and trees surrounded by farmland paths and winding water. Li (2007) referred to "Linpan" as an organic integration of Chengdu rural home courtyards with the surrounding natural environment, which consisted of tall trees, bamboo forests, and human and peripheral farmland, forming a beautiful and harmonious rural living environment, like a green island in the plain. Zhang (2008) explained that "Linpan" combines the Dujiangyan irrigation system, agricultural production, colony family, and local lifestyles. More importantly, he highlighted that "Linpan" integrates life, production, and ecological environments as one, which is a spatial structure that has both cultural and functional values. At the same time, Cai (2009) also highlighted the combination of 宅(*zhai*, literally known as farmhouse), farmland, forest, and human in "Linpan". In short, it is clear to see that 'Lipan' - a typical but unique cultural landscape in Chengdu - is a production of interaction between human activities and nature. Lastly, the natural conditions of Chengdu plain - with excellent geography, fertile soil, exquisite water resources, and temperate climate - are also important to the formation of "Linpan" as well. It has created good living conditions for agricultural production and rural communities (Wang, 2010).

## Spatial Pattern Of 'Linpan': A Significant Characteristic Of Rural Farming Settlement In Chengdu Plain

'Linpan' (Figures 1.2 and 1.3) is basically composed of buildings, vegetable fields, woodlands, and farmlands. The courtyard extending from the house is the core of 'Linpan', followed by vegetable fields, woodlands, farmland, and water bodies (water irrigation canal or pond). The courtyard is surrounded by a house, wall, and fence. The first outer part of the courtyard is surrounded by vegetable fields, flower and fruit trees, which are needed for residents' daily life. The second outer part of 'Linpan' is the forest which includes tall trees and bamboo. The third outer part is farmland, which is convenient for residents to cultivate crops (Sun, 2019). The 'Linpan' layout is homogenous; as it expands and develops to a larger scale, it still maintains the pattern of expanding outwards from the central courtyard to more houses and a larger forest. Likewise, larger farmlands are developed around the periphery of each forest.



Figure 1.2: Picture of 'Linpan' (Source:Author)
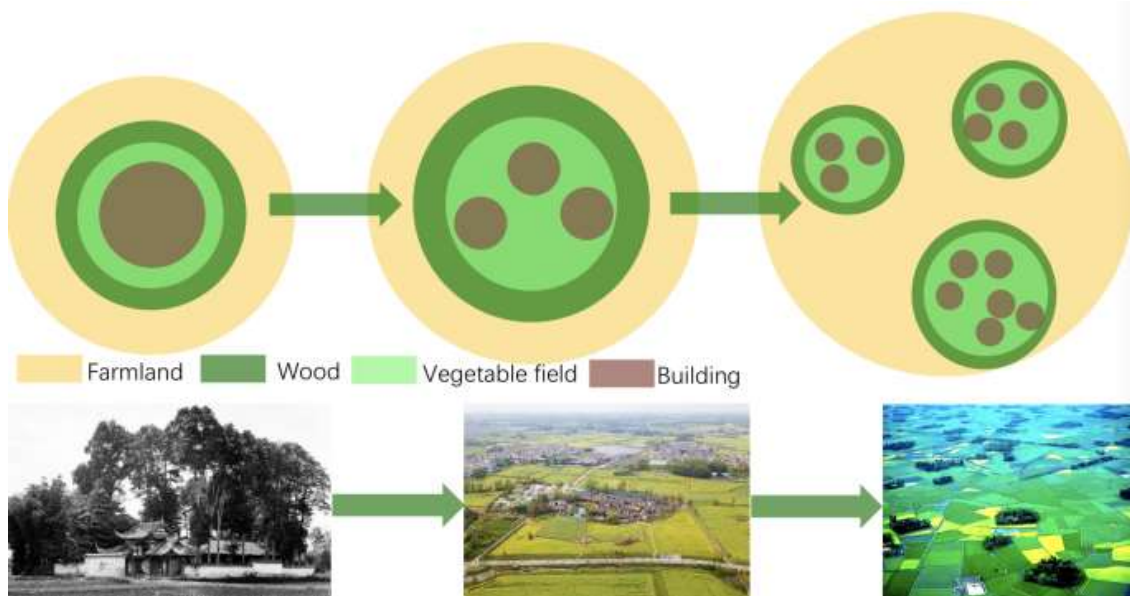
Figure 1.3: Picture of 'Linpan' development
(Source:Author)

## ISSUES FACED BY 'Linpan'

### Decrease in the number of 'Linpan'

With the development of industrialization and mechanization, traditional farming production and way of life are being replaced by large-scale, industrialized agricultural production methods, and the same to the lifestyle of urban and new rural communities (Cai, 2020). The number of 'Linpan' is rapidly declining and is even on the verge of disappearing. Furthermore, with the fast development of urbanization, urban lands are expanded at a rapid rate, which resulted in the decline of agricultural lands in Chengdu, including 'Linpan'. At the end of 1986, the urban area of Chengdu was only 70km$^2$; however, by 2009, the built-up area of Chengdu's city had exceeded 400km$^2$, with a future planning area of 598km$^2$ (Wang, 2018). Due to the large expansion of Chengdu urban area, the original 'Linpan' has almost disappeared. Only a small amount of 'Linpan' remained and are surviving in the margin area of the city.

### Hollowing of 'Linpan'

Hollowing of 'Linpan' is another substantial factor for the reduction of 'Linpan'. The hollowing of 'Linpan' refers to the deterioration of 'Linpan''s living environment, including the dilapidated farm houses and courtyard, as well as the vacancy of living rooms in 'Linpan's settlement centre, (Fang, 2019). From a macroscopic perspective, the formation of "hollowing 'Linpan' is the result of urbanization. The new agricultural economy and the changing employment structure in process of rural modernization led to the physical and social changes of 'Linpan' settlement. In addition, from microscopic perspective, it is caused by the "hollowing households" when there is no residents sitting in the house. It illustrates the existence of compounds that have been unoccupied for long time but have a householder (Cai, 2020) (Figures 1.4)



Figure 1.4: Hollowing 'Linpan'
(Source:Author)

### Lack of public service infrastructure in 'Linpan' areas

The lack of rural education and medical services and the monotonicity of rural cultural life are intangible factors that caused the decline of 'Linpan'. The quality of primary education in rural 'Linpan' is poor, hence there is a large number of rural children are sent to study in the city area in order to seek better educational resources. Most rural primary schools have also been seriously affected and closed due to the decline in student numbers. In this case, children still have to leave their 'Linpan' and go to study in the city to study. Most of the time, due to that, the parents will accompany them. The large outflow of the population, especially the young and middle-aged residents, resulted in further "hollowing 'Linpan'. The low population inevitably led to poor support for public medical services which resulted in the backwardness of the rural medical service system.

On the one hand, the decrease in rural population leads to the withdrawal of all kinds of public economic services and production services in rural areas. When the rural public service infrastructure is re-planned, they are mostly concentrated in the rural road interchange areas with convenient transportation. Unfortunately, most of the 'Linpan' are located far away or even outside of these locations of new public service infrastructure areas. This makes the life of residents become inconvenient and reduces the quality of life of residents. In short, the poor rural infrastructure is also one of the reasons leading to "hollowing 'Linpan'.

**'Linpan' cultures are facing the disappearance**

'Linpan' is the main integrate place of folk culture in western Sichuan. 'Linpan' is rich in culture which includes Chinese traditional farming civilization, the history and kinds of immigration culture.

'Linpan' faces disappearance because of urbanization (He, 2015). Due to the process of urbanization, the traditional rural areas are decreasing, and most of the traditional folk culture has then disappeared. The widening gap between urban and rural areas has caused a large loss of rural elites. The traditional agricultural culture and folk culture concepts have become increasingly weak as rural youth have been living and working in cities. At present, there are many negative phenomena in rural areas, such as the collapse of traditional community, the relaxation of traditional morality, the confusion of social values, the decline of cohesion and the decline of mutual aid spirit. The hollowing 'Linpan' and the decline of cohesion of residents led to the reduction or even disappearance of traditional cultural activities. In the past, it was difficult to carry out activities such as opera, lion dance and dragon lantern dancing, which required many local residents to participate in.

In conclusion, there haven't been studies on the conservation and resilience of 'Linpan''s cultural landscape in China compared to other studies on reconstructions and development such as forest and heritage architecture.

## EXISTING RESEARCH ON 'Linpan', CULTURAL LANDSCAPE AND RESILIENCE IN CHINA: ISSUES & CHALLENGES

### The research results of 'Linpan' in China

The research on 'Linpan' is mainly concentrated in China. It also mainly concentrates on local scholars who are from Sichuan Agricultural University, Southwest Jiao Tong University, and Sichuan University. However, in comparison with domestic other research, 'Linpan' is not enough paid attention by scholars. The research results of the 'Linpan' are still limited. Since 2008, 'Linpan' has begun to receive attention from indigenous scholars who have started to discuss the value of 'Linpan' in terms of culture, ecology, landscape, etc. In recent years, 'Linpan' has attracted widespread attention and the number of scholars studied on 'Linpan' has been

increasing, mainly from Sichuan university. Most of the research still only discussed on the values of 'Linpan'.

'Linpan's in Chengdu Plainn is the material carrier of Shu culture, rich in cultural, ecological, social, and aesthetic values. (Cai, 2009; Lei, 2010; Wan, 2013; Sun, 2019; Tang, 2020; Xiong, 2022). 'Linpan' has a long history, and its rich cultural value has always been a concern for scholars. For example, Sun (2019) believed that 'Linpan' is the precipitation of Chengdu's cultural heritage and the spiritual embodiment of Chengdu culture, and did discuss the ecological value of 'Linpan' from the perspective of landscape morphology. Fang (2019) made a detailed discussion on the evolution of the cultural landscape of 'Linpan' including the impact of economic production, immigrant societies, cultural practices. Li (2011), Xue (2013), Chen (2019), Sun (2011), and Luo (2019) explored the values of 'Linpan' through these four aspects: the carrier of Shu culture, ecological value, idyllic landscapes, and cultural landscapes. After this, Long (2013), Xu (2014), and Sun (2011) studied the relationship between migrant and farming culture in 'Linpan'. The 'Linpan' is distributed in the vast rural areas of Chengdu City, which is rich in woodland resources and vegetation resources.

Other than that, some scholars have analyzed the ecological value of 'Linpan' from a comprehensive perspective. Zheng (2010) has analyzed the ecological effects of the elements of 'Linpan' (woodland, farmland, and residential areas) and concluded that it has important ecological value. The research on the ecological value of 'Linpan' is mainly reflected in the plant community and related to its microclimate. Yang (2011) did an overall survey and explored the ecology of the flora in 'Linpan'.

According to Wan (2013) and Xue (2011), 'Linpan' also plays an important role in the influence of microclimate. They analyzed the internal climate environment of 'Linpan' by using the CFD (Computational Fluid Dynamics) method and then proposed some ecological planning measures to improve the microclimate of 'Linpan'. By analyzing the changes in the microclimate of the 'Linpan' at different scales, Liu (2016); Cao (2018); Zhang (2019) concluded that the 'Linpan' has great ecological benefits to the surrounding environment.

Moreover, as for the aesthetic value of the 'Linpan', Sun (2019) summarized the landscape imagery of the 'Linpan' in the five aspects - entrance, plants, color, vegetation, and space - and then explained them through the MDP measurement system. Finally, the image structure of 'Linpan' is refined and applied, which provides an analysis of the artistic value.

In addition, some scholars found that the rural economy plays a significant role in the sustainability of 'Linpan'. They suggested improving the rural economy through introducing tourism in 'Linpan' (Li, 2011; Tan, 2019 Cao, 2019). 'Linpan' settlement retains many aspects of traditional Chinese farming culture, at the same time, the layout of 'Linpan' settlement is quite unique as an attraction to tourists. 'Linpan' settlement size can be divided into three types through the number of farmhouses: more than 20 farmhouses are big 'Linpan' ; 6-20 farmhouses are medium 'Linpan', 3-5 farmhouses are small 'Linpan' (Wen, 2008; Liu 2012; Wang, 2013; Chen, 2013).

**The research results of cultural landscape in China**

The cultural landscape is a relatively new but important subject for regional cultural studies. For regional culture and characteristics, the cultural landscape is the landscape quality of a place and the comprehensive presentation of the regional locality. Han (2007) introduced the concept of cultural landscape in China and pointed out that cultural landscape is a new theoretical perspective for cultural heritage research. Furthermore, basic research on space and typology is a

necessary part of cultural landscape research. Du (2016) and Li (2018) pointed out that the indigenous landscape is related to the specific natural and social contexts in the region. According to Huang (2014), locality is a continuous social construction in four dimensions: landscape, text, symbol, and perception. The whole process is in a dynamic state of evolution. Tang (2013) suggested that the mutual influence of locality and tourism development is very important. Cai (2006) proposed the types of cultural landscape heritage in China and explored the methodology of the conservation process of various types of cultural landscapes.

China is rich in regional cultural landscapes because of its thousands of years of civilization. Its identity has formed in diverse and unique regional cultural landscapes. Many scholars in China are doing research based on a particular provincial administrative region. For example, Yang et al. (2000) studied the cultural landscape of Shanxi region; Li et al., (2012) studied the cultural landscape of Hebei region; Gao (1996) studied the cultural landscape of Yunnan region, and Wang et al.,(2012) did a holistic study of the cultural landscape of Qinghai region. Besides, some cultural studies were made based on the concept of "cultural routes".

In terms of the protection of the cultural landscape, Wang Yuncai et al., (2014) took Luzhi Town of Suzhou City as a case study. The characteristics and formation process of the traditional cultural landscape of the ancient town are analyzed based on the analysis of regional characteristics. Protecting Luzhi town through determining the protection circle layer and constructing the ecological network of the cultural landscape. Also, Li et al. (2009) used GIS methods to extract historical spatial data from historical maps and documents in order to interpret the spatial and temporal evolution of Foshan's clan cultural landscape and its socio-cultural spatial significance for landscape restoration and map reproduction use. Xiao (2014) analyzed the environment, pattern, clusters, streets, landmarks, and

behaviors of historical settlements, and also their cultural connotations from the perspective of the unity of materiality and value.

## The research results of resilience studies in China

The concept of resilience is still new in China, especially in terms of ecology. The concept of ecological resilience, first proposed by C.S. Holling in 1973, is "a measure of the persistence of a system and its ability to absorb changes and disturbances and maintain the same relationships between population or state variables" (Holling, 1973). In other words, resilience is defined as the tendency of a system to maintain its organizational structure and productivity after a perturbation (Holling, 1973). Although the concept of resilience originates from the study of predator-prey interactions and their functional responses in relation to theories of ecological stability, the concept rapidly gained currency among other natural and social scientists (Folke, 2006). To better understand and improve the definition, a large number of related concepts have emerged in the literature on the understanding and applicability of so-called ecological or socio-ecological resilience. Basically, it includes a spatially orientated complex adaptive system, including social and ecological components and their interactions (Cumming, 2011). It can be referred to as a social-ecological system that linked humans and nature, in which humans depend on nature and nature is impacted by humans (Berkes et al., 2003); Vulnerability, is also being studied. It is a state of being susceptible to the stresses associated with environmental and social change and the lack of adaptive capacity (Adger, 2006). Adaptability is another subject in studying resilience because it is the ability to adjust to multiple disruptions, mitigate potential damage, capitalize on opportunities, and cope with the consequences of shifts that occur (Gallopín, 2006).

Based on foreign works of literature on resilience, the concept of resilience was introduced in China by Fu (2017). However, there are very few scholars doing research on the resilience of cultural landscapes. Sun (2022) used the SRP model to construct an ecological vulnerability evaluation index system for Xinjiang, combined with the spatial principal component analysis method to construct an ecological vulnerability index evaluation model, which resulted in the main driving forces of ecological vulnerability, include agricultural dependence, population density, and land reclamation rate. It was to determine whether the relationship between people and the land is harmonious or contradictory, determined not by the land but by the people, and from the viewpoint of spatial resilience. The natural and social spatial variables of the system are affected by both spatial resilience.

Effective spatial planning and management policies are important drivers of ecosystem restoration (Wang, 2018; Fu, 2020; Zhao, 2021). According to Fu (2017) used SEPLS (Socio-ecological Production Landscapes and Seascapes) to analyze the ecological effects and resilience characteristics of Shanghai urban landscape, the result showed that the main factors affecting urban resilience were identified as surface permeable substrate structure and population density. Lastly, community cooperative regulatory development mechanisms are also conducive to increasing or maintaining the carrying capacity of natural resources, the resilience of community landscapes, and existing ecological management policies, leading to positive interactions and the development of "socio-ecological-cultural" systems (Qiu, 2023).

## CONCLUSION

Conclusively, this paper has examined the resilience of 'Linpan' cultural landscapes based on existing pieces of literature on 'Linpan', cultural landscapes, and resilience in China. Current research on 'Linpan' focused on value, characteristics, history, rural economy, and landscape resilience research is yet well developed for vulnerability assessment, socio-ecological system analysis, and adaptive management. Its conservation and management plans are less discussed for the resilience of 'Linpan' cultural landscape.

Also, despite the concept of "resilience" has been rapidly emerging for economic and social development, it is a lack of research about cultural landscape resilience in China, including the resilience of 'Linpan' cultural landscape. It is necessary to focus on cultural resilience at different levels and scales. This paper also found that ecosystem resilience (Holling, 1973) is important in studying cultural resilience because it interconnected socio-ecological systems (Gunderson and Holling, 2002; Folke, 2006).

It is acknowledged that resilience is the ability to handle disturbances or changes without altering the essential characteristics of the system. It is also the ability to absorb disturbances and reorganize when changes are made in order to maintain essentially the same function, and structure. Thus, researchers should suggest a practical approach or framework for better understanding complex social-ecological systems so that it can help to maintain the productivity, health, and longevity of cultural landscapes in China. As the research on resilience continues to expand from the early single-level ecosystem resilience to multi-scale perspectives, the interactions between social and ecological systems continue to change and change again based on contemporary development, issues, and challenges.

Therefore, the core of the resilience of 'Linpan' cultural landscape will be finally based on an adaptive planning and management framework. In other words, no matter how urbanization has led to significant changes in rural cultural landscapes, the adaptive management of rural cultural landscapes can be effective

sustainable to cope with future uncertainty and complexity. 'Linpan''s resilience, perhaps, should concentrate on the process of destruction and reorganization, or breakdown and renewal.

## ACKNOWLEDGEMENT

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# GEOINFORMATION

# ASSESSING THE REALIBILITY OF SITE VELOCITY PREDICTION USING GPS-DERIVED SITE VELOCITY AND PREDICTED VELOCITY

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## ABSTRACT

Site velocity is an important parameter to describe the regional crustal deformation. GPS-derived site velocity can be computed via Global Positioning System (GPS) coordinate time series and can be predicted using the plate motion model. Hence, this study focused on the capability of the GPS-derived site velocity, respective to the predicted velocities via global plate motion model. An assessment has been carried out between GPS-derived site velocity and predicted velocity from the plate motion model with the aid of Global Navigation Satellite System (GNSS) Continuously Operating Reference Station (CORS) network such as Malaysian Real-Time Kinematic GNSS Network (MyRTKnet) data. The result from the GPS processing indicates that the residual between the observed and the predicted velocity from the plate motion model for MyRTKnet sites shows discrepancies up to 8mm, horizontally. Hence, the findings of this study will give an insight towards the present-day plate motion as compared to the modelled plate motion.

*Keywords : Site Velocity, Crustal Deformation, Plate Motion Model*

## INTRODUCTION

 Recent series of megathrusts earthquake; 2004 Sumatra Andaman (9.2Mw), 2005 Nias Simeulue (8.5Mw), 2007 Bengkulu (7.9Mw) and 2012 Indian Ocean (8.6Mw) have caused a significant crustal deformation with displacement by up to 39cm/year within central of Sundaland (Aris et al., 2018; Gunawan et al., 2016; Feng et al., 2015). A steady-state motion associated with plate tectonic motion is classified as secular motion while, co-seismic, post-seismic and post-seismic decay are classified as non-secular motion (Shariff, 2018; Gómez et al., 2016).

 The occurrences of these major earthquakes resulted in long term non-secular of crustal deformation within the Sunda block (Paul et al., 2012). The occurrences of secular and non-secular crustal deformation from year 2004 until 2012 had caused significant displacement towards the geodetic infrastructures in Southeast Asia. Whereby the existing static geodetic control network and datum has been distorted by the effect of the crustal deformation including in Malaysia region (DSMM, 2021; Alaneme et al, 2018). A study by Yong et al, (2017) also

shows that Peninsular Malaysia undergoes significant post seismic deformation up to an average of 14.0 mm/year. Although this relative motion and distortions of cadastral boundary coordinates are considered small, accumulated motion over a period of a few years should not be ignored and would eventually conflict with the static reference frame (Shariff et al., 2017; Yang et al., 2019).

In recent years, through the advancement in GNSS technology, GPS-derived site velocity can be computed via coordinate time series and can be predicted using the open source plate motion model. Hence, this study intends to examine the capability of both method in velocity prediction.

## METHODOLOGY

In quantifying velocity prediction, within the GPS CORS network in Sundaland, this study has been phased into three stages. The first stage involves determining the observed velocity, followed by the second stage, involves determining the predicted velocity using the NNR-MORVEL56 plate motion model. The final phase of this study entails evaluating the site velocity predictions derived from both methods.
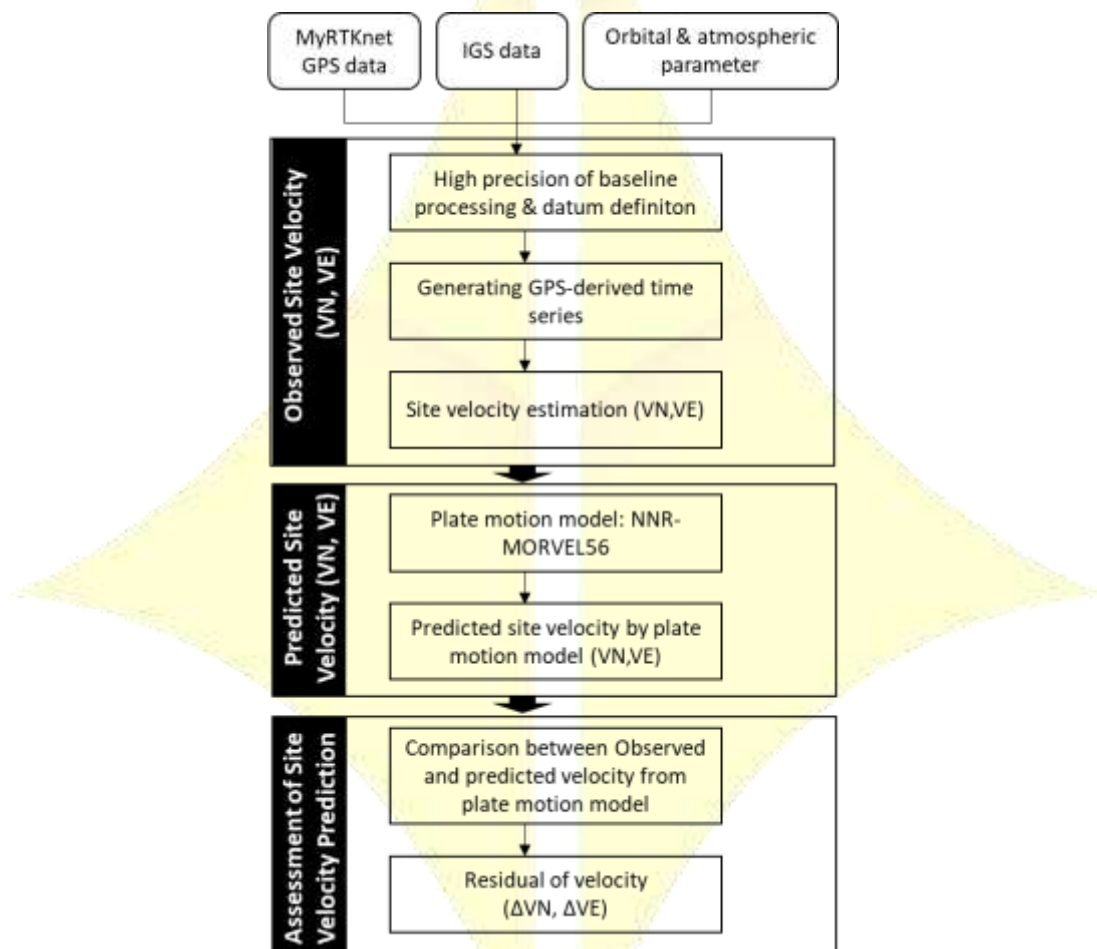


**Figure 1.** Methodology of the study.

Daily GPS solutions of year 2015 were constrained to International Terrestrial Reference Frame 2014 (ITRF2014) datum for selected MyRTKnet sites within Peninsular Malaysia and Borneo region. In this study, two approach has been implemented; first is GPS-derived velocity and second is site velocity prediction via plate motion model. In the first stage, the site velocity of each station was estimated by applying linear regression model in the CTS based on the equation [1];

$$y = at + b \qquad\qquad [1]$$

where t is time in day of year, a and b is the coefficients to be estimated which is velocity. It is to present the significant movement at each station.

On the other hand, the second phase is site velocity prediction via plate motion model requires the knowledge of the location of site in 3D Cartesian coordinates or geographical coordinates along with its Euler Pole parameters. According to Goudarzi et al. (2014), the Euler theorem can be mathematically formulated as follows [2]:

$$v_i^p = \Omega^p \times x_i$$
$$= \begin{bmatrix} 0 & -\omega_z & \omega_y \\ \omega_z & 0 & -\omega_x \\ -\omega_y & \omega_x & 0 \end{bmatrix}^p \begin{bmatrix} x \\ y \\ z \end{bmatrix}_i \qquad [2]$$

where $v_i^p$ and $x_i(x_i y_i z_i)^T$ are the velocity and the position of the station $i$, and $\Omega^p(\omega_x^p \omega_y^p \omega_z^p)$ is the angular velocity or the Euler vector of the plate $p$ associated with the station $i$. In accordance with the

Eular theorem, the global plate motion model, the NNR-MORVEL56 (Argus et al., 2011) can be predicted using the UNAVCO Plate Motion Calculator.

## MAIN RESULTS

This section comprises of three subsection for explanation of GPS-derived site velocities of MyRTKnet station, predicted velocities from plate motion model; NNR-MORVEL56 and the assessment on the performance of site velocity prediction.

**GPS-derived Site Velocities of MyRTKnet stations.**

GPS Coordinate Time Series (CTS) for the selected MyRTKnet stations were plotted and velocity for each of the stations were estimated by applying Equation 1 into the time series. Figure 2 and Figure 3 shows the time series plotted for MyRTKnet stations; USMP in Peninsular Malaysia and BIN1 in East Malaysia respectively. Estimated velocities for these stations are shown in Table 1.
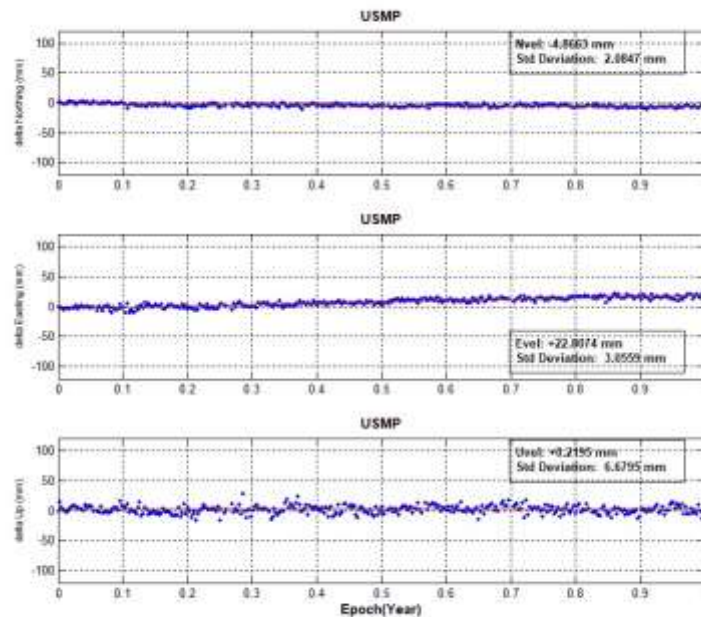


Figure 2. GPS CTS of MyRTKnet station in Peninsular Malaysia; USMP station.
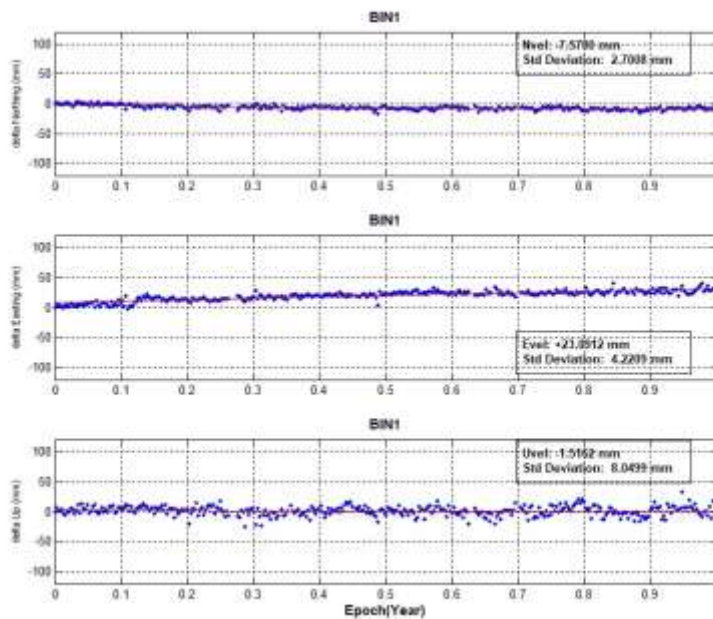
Figure 3. GPS CTS of MyRTKnet station in East Malaysia; BIN1 station.

Table 1. Observed velocities at MyRTKnet stations.

| Station | Observed Velocity | |
|---|---|---|
| | Vn (mm) | Ve (mm) |
| BEAU | -7.745 | 18.705 |
| BIN1 | -7.758 | 23.091 |
| JRNT | -6.157 | 22.766 |
| KENI | -9.786 | 17.079 |
| LIPI | -1.877 | 21.023 |
| MIRI | -9.495 | 19.825 |
| MRDI | -7.997 | 21.001 |
| MUAD | -4.190 | 22.485 |
| MUKA | -10.086 | 24.873 |
| PASP | -4.326 | 20.942 |
| PRTS | -4.033 | 25.292 |
| SARA | -8.856 | 22.299 |
| SEG1 | -1.930 | 25.827 |
| TOKA | -5.369 | 18.087 |
| USMP | -4.866 | 22.807 |

Referring to Figure 2, Figure 3 and Table 1, MyRTKnet stations shows a south-eastward trend of motion at an average velocity of 22 mm/year. Based on this trend, it can be seen that all the stations are progressing in a linear motion due to the major earthquake in 2012.

**Predicted Velocities from Plate Motion Model; NNRMORVEL56.**

Velocity prediction was carried out with the knowledge of the station locations along with its Euler pole parameters by applying Equation 2. Table 2 shows the predicted site velocity, deducted from plate motion model; NNR-MORVEL56.

Table 2. Predicted velocities at MyRTKnet stations.

| Station | NNR-MORVEL56 | |
|---|---|---|
| | Vn (mm/yr) | Ve (mm/yr) |
| BEAU | -12.31 | 30.56 |
| BIN1 | -11.35 | 29.91 |
| JRNT | -7.20 | 30.26 |
| KENI | -12.48 | 30.55 |
| LIPI | -7.09 | 30.35 |
| MIRI | -11.68 | 30.28 |
| MRDI | -11.81 | 30.21 |
| MUAD | -7.48 | 29.94 |
| MUKA | -10.95 | 29.80 |
| PASP | -7.19 | 30.94 |
| PRTS | -7.40 | 29.53 |
| SARA | -10.69 | 29.41 |
| SEG1 | -7.34 | 29.72 |
| TOKA | -6.40 | 31.03 |
| USMP | -6.36 | 30.79 |

Referring to Table 2, predicted velocities using plate motion model; NNR-MORVEL56 for MyRTKnet stations shows a trend of south-eastward motion at an average of 30 mm/year. Based on this results, slight difference between the observed velocity and predicted velocity shows that both methods are suitable to be

used in particularly in Malaysia.

**Analysis on Performance of Site Velocity Prediction.**

An assessment has been analyse through the residuals between GPS-derived site velocity and predicted velocity from the plate motion model in this section. Table 3 shows the residuals between GPS-derived observed velocities and predicted velocities from NNR-MORVEL56.

Table 3. Residual between predicted and observed velocity.

| STATIONS | Residual between Predicted and Observed Velocity | |
|---|---|---|
| | Vn (mm/yr) | Ve (mm/yr) |
| BEAU | -4.565 | 11.855 |
| BIN1 | -3.592 | 6.819 |
| JRNT | -1.043 | 7.494 |
| KENI | -2.694 | 13.471 |
| LIPI | -5.213 | 9.327 |
| MIRI | -2.185 | 10.455 |
| MRDI | -3.813 | 9.209 |
| MUAD | -3.290 | 7.455 |
| MUKA | -0.864 | 4.927 |
| PASP | -2.864 | 9.998 |
| PRTS | -3.367 | 4.238 |
| SARA | -1.834 | 7.111 |
| SEG1 | -5.410 | 3.893 |
| TOKA | -1.031 | 12.943 |
| USMP | -1.494 | 7.983 |

Referring to Table 3, residual in predicted site velocity and obeserved velocity shows offset averaging at 3-8mm. The result indicates that both method shows a small residual, despite MyRTKnet station were expected to still induced by the effects of the major earthquakes within the post-seismic decay period. Figure 5 and Figure 6 shows the observed and predicted velocity vector plot for MyRTKnet station in Malaysia.
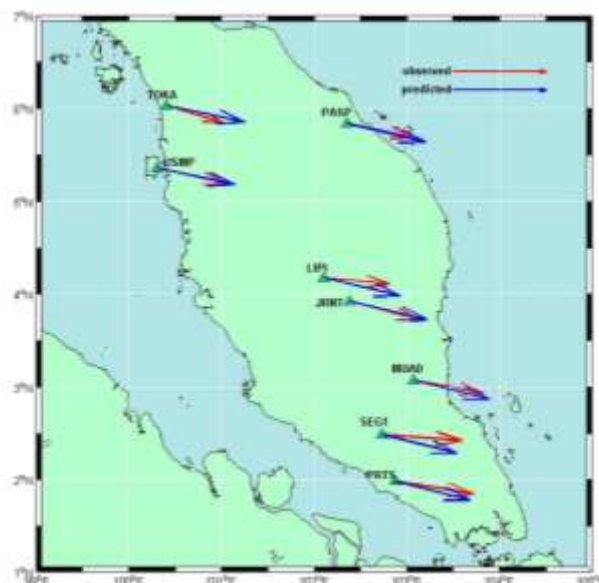


Figure 4. Predicted NNR-MORVEL56 velocity with observed velocity vector plot of MyRTKnet stations in Peninsular Malaysia.
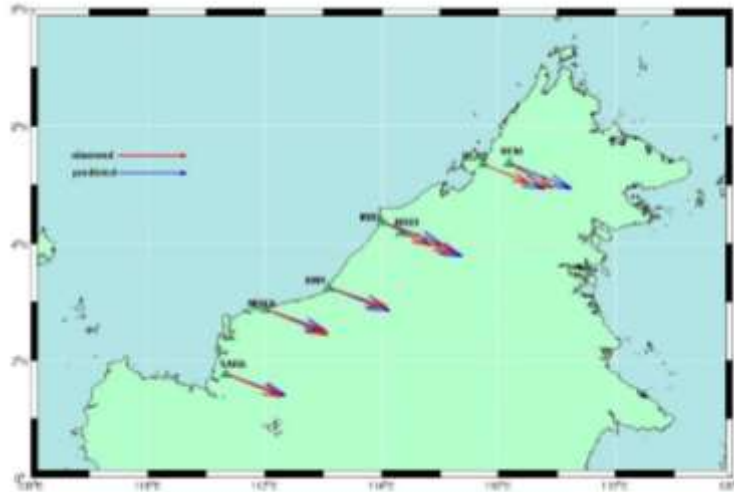
Figure 5. Predicted NNR-MORVEL56 velocity with observed velocity vector plot of MyRTKnet stations in East Malaysia.

## CONCLUSION

The observed velocity of MyRTKnet shows a trend of south-eastward motion at an average of 22mm/year while the NNR-MORVEL56 velocity prediction shows that the sites are trending south-east motion at an average of 30mm/year. The residuals between the observed and predicted velocity from NNR-MORVEL56 for MyRTKnet sites are relatively small, averaging at 3-8mm. This results indicates that both method are suitable and efficient in predicting velocities in this region.

## ACKNOWLEDGEMENT

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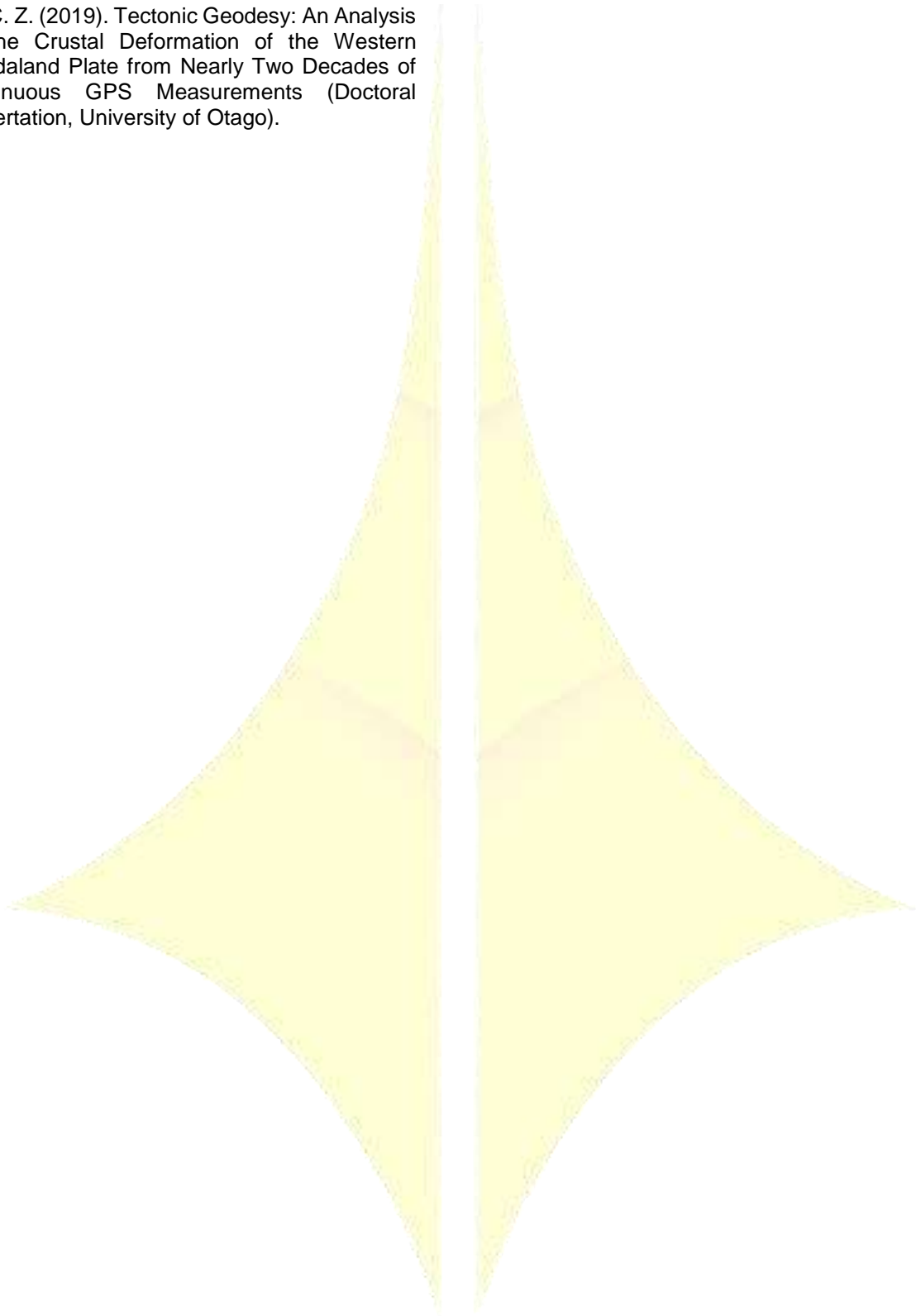
# ASSESSING ACCURACY OF PRECISE POINT POSITIONING IN MALAYSIA USING GPS EPHEMERIDES WITH DIFFERENT DURATION

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## ABSTRACT

Precise Point Positioning (PPP) is an absolute positioning technique in GPS positioning that could provide sub-decimeter accuracy. The accuracy is dependent on the type of ephemerides and duration of GPS measurement data used. This paper aims to investigate accuracy of PPP in Malaysia that is affected by the relationship between the duration of data required and the type of ephemerides. GPS measurements from Continuous Operating Reference Station (CORS) in Malaysia with duration of 15 minutes, 30 minutes, 1 hour, 2 hours, 4 hours, 6 hours, 8 hours, 12 hours, and 24 hours was processed using ultra-rapid, rapid and final ephemeris from International GNSS Service (IGS). RTKLIB was used to process the GPS measurements using the built-in PPP static algorithm. The accuracy is validated by comparing the estimated coordinate using PPP and the known coordinate of the CORS. The result is compared across different durations to determine the optimum duration required for each type of ephemeris to achieve decimeter and sub decimeter accuracy. The result is also analysed from three components namely 3D, 2D and height. Decimeter accuracy can be achieved using a minimum of 15 minutes of data in all components for all precise ephemerides used. 3D sub decimeter accuracy can be achieved by using 8 hours of data for rapid and final ephemerides, 2D sub decimeter accuracy is achieved using 2 hours of data for all precise ephemerides while height sub decimeter accuracy was achieved by using 24 hours data for ultra-rapid ephemeris and 8 hours data for rapid and final ephemerides.

*Keywords : Precise Point Positioning, GPS Ephemerides, GPS duration, GPS Positioning in Malaysia.*

## INTRODUCTION

GPS is a satellite-based positioning system that has been widely used to support positioning, navigation and timing (PNT) purposes. GPS has achieved full operational since 1995 and has been the most widely used Global Navigation Satellite System (GNSS) in the whole world (O'Connor et al., 2019).

The accuracy of GPS varies from meter to millimeter, depending on the duration of observation and positioning techniques. Positioning techniques are broadly categorized into two, namely absolute

positioning and relative positioning (Hofmann-Wellenhof et al., 2012). Single receiver is sufficient to determine user position in absolute positioning, compared to relative positioning that requires two or more receivers.

There are two main processing technique in absolute positioning, namely single point positioning (SPP) and PPP. SPP is able to provide positioning with metre level accuracy while PPP could provide sub-decimeter accuracy (Hofmann-Wellenhof, Lichtenegger, & Collins, 2012). PPP is characterized by the usage of precise ephemerides, an information file that contains highly accurate satellite position and satellite clock (Kouba & Héroux, 2001). Table 1 shows the types of ephemerides available and their performance. Among the ephemerides, ultra-rapid, rapid, and final are also collectively known as precise ephemerides.

**Table 1** Types and performance of ephemerides (Johnston et al., 2017).

| | Type | Accuracy | Latency |
|---|---|---|---|
| Broadcast | Orbit | 100 cm | Real time |
| | Satellite clock | 5 ns RMS 2.5 ns standard deviation | |
| Ultra-rapid (predicted half) | Orbit | 5 cm | Real time |
| | Satellite clock | 3 ns RMS 1.5 ns standard deviation | |
| Ultra-rapid (observed half) | Orbit | 3 cm | 3 – 9 hours |
| | Satellite clock | 150 ps RMS 50 ps standard deviation | |
| Rapid | Orbit | 2.5 cm | 17 – 41 hours |
| | Satellite clock | 75 ps RMS 25 ps | |
| | | standard deviation | |
| Final | Orbit | 2.5 cm | 12 – 18 days |
| | Satellite clock | 5 ns RMS 2.5 ns standard deviation | |

The aim of this study is to investigate the accuracy of PPP in Malaysia when different ephemerides with varying duration of data is used.

## METHODOLOGY

GPS measurement data with 30 seconds per epoch from 13 March 2020 was used in this study. The measurements were taken from a total of sixty-eight (68) CORS station from Malaysia Real-Time Kinematic Network (MyRTKnet). Figure 1 shows the distribution of the CORS.
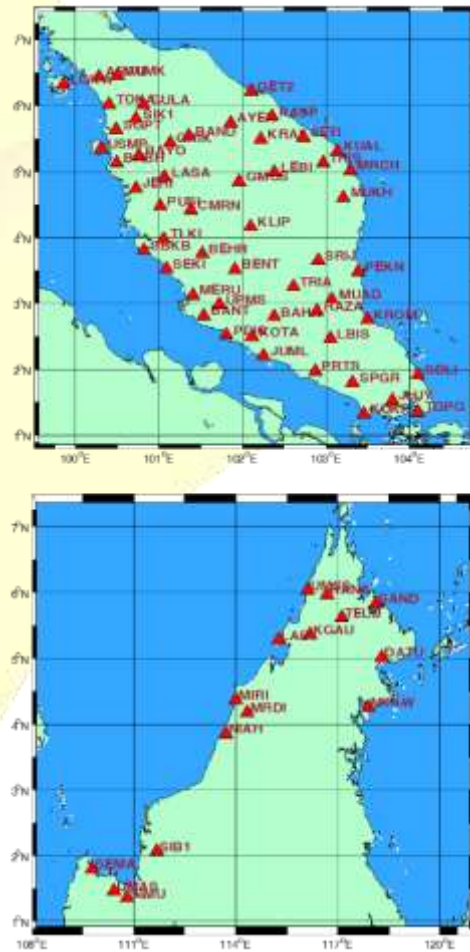


**Figure 1** Distribution of CORS used in the study.

PPP is performed using the PPP module

in RTKLIB. RTKLIB is an open-source processing software that includes many modules, including PPP (Takasu, 2017). Figure 2 shows the settings of PPP module in RTKLIB used in this study.
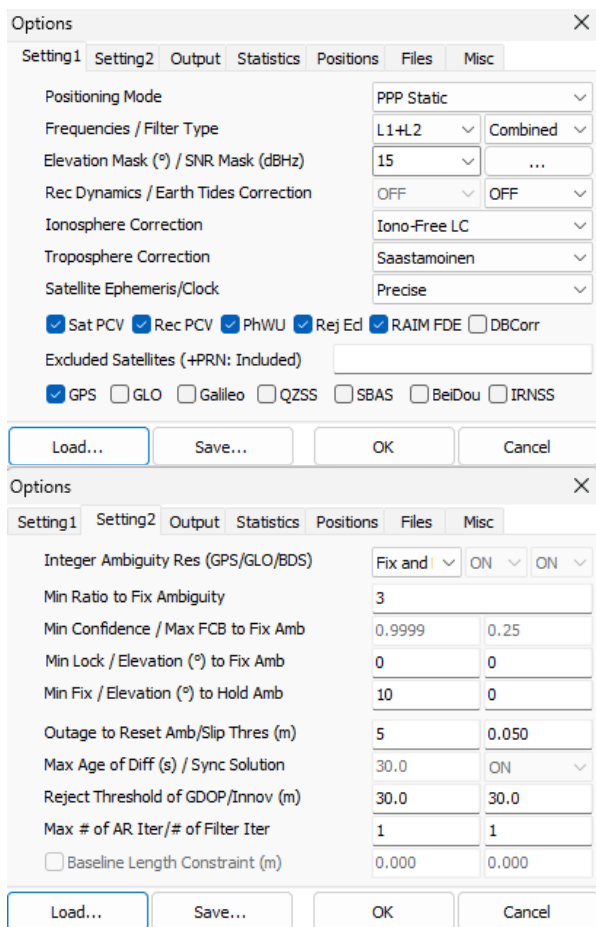


**Figure 2** RTKLIB settings for PPP processing used in this study.

Ultra-rapid (observed half), rapid and final ephemerides were used in this study. Each ephemeris was processed using duration of 15 minutes, 30 minutes, 1 hour, 2 hours, 4 hours, 6 hours, 8 hours, 12 hours, and 24 hours.

The output coordinate is then compared against the known coordinate of the CORS in International Terrestrial Reference Frame 2014 (ITRF2014) to assess the accuracy of PPP. The coordinate of CORS in MyRTKnet were initially in Geocentric Datum of Malaysia 2000 (GDM2000). The coordinate was first processed to tie to ITRF2014 using high precision GNSS processing software before comparison can be made.

The accuracy is assessed using root-mean-squared error (RMSE). The solution is also analysed from a 3D, 2D and height perspective. The 3D coordinate is projected into Universal Tranverse Mercator (UTM) to get 2D coordinate in northing and easting.

## RESULT AND ANALYSIS

Figure 3 shows the 3D accuracy of PPP solution using different ephemerides with varying duration of data.

All PPP solution can achieve decimeter 3D accuracy with minimum 15 minutes of data, regardless of precise ephemerides used. Sub-decimeter accuracy can only be achieved by rapid and final ephemerides, with minimum of 8 hours data.

Using 8 hours data, PPP can achieve accuracy of 0.0985 m and 0.0983 m for rapid and final ephemerides respectively. This is a slight improvement of 0.2% in 3D accuracy when comparing final ephemeris against rapid ephemeris.

Navigation is more concerned on planar coordinates, or more often referred as 2D coordinates. Figure 4 shows the 2D accuracy of PPP solution using different ephemerides with varying duration of data.

All PPP solution can achieve decimeter 2D accuracy with minimum 15 minutes of data, regardless of precise ephemerides used. Sub-decimeter accuracy achieved by all precise ephemerides, with minimum of 2 hours data.

Using 2 hours data, PPP can achieve 2D accuracy of 0.0890 m, 0.0818 m, and 0.0805 m for ultra-rapid, rapid and final ephemerides respectively. The improvement of final ephemeris over ultra-rapid and rapid ephemerides are 9.55% and 1.59% respectively while rapid ephemeris improve by 8.09% over ultra-rapid ephemeris for 2D accuracy.

Heighting also plays a major role in positioning, especially for height-related positioning such as hydrography survey. Figure 5 shows the height accuracy of

PPP solution using different ephemerides with varying duration of data.

All PPP solution can achieve decimeter height accuracy with minimum 15 minutes of data, regardless of precise ephemerides used. Sub-decimeter accuracy was achieved by all precise ephemerides, whereby ultra-rapid ephemeris requires 24 hours of data while rapid and final ephemerides needs only 8 hours of data.

PPP can achieve height accuracy of 0.0936 m and 0.0935 m for rapid and final ephemerides respectively, using 8 hours of data. Final ephemeris shows a slight improvement of 0.11% over rapid ephemeris in height accuracy.

Table 2 summarizes the accuracy achievable by PPP solutions using different ephemerides with varying duration.

**Table 2** Accuracy achievable by PPP solutions using different ephemerides with varying duration.

| EPHEMERIS | 3D RMSE (M) | | | 2D RMSE (M) | | | HEIGHT RMSE (M) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Ultra-rapid | Rapid | Final | Ultra-rapid | Rapid | Final | Ultra-rapid | Rapid | Final |
| 15 MINUTES | 0.798 | 0.802 | 0.794 | 0.545 | 0.547 | 0.544 | 0.568 | 0.571 | 0.565 |
| 30 MINUTES | 0.549 | 0.547 | 0.541 | 0.378 | 0.372 | 0.368 | 0.391 | 0.395 | 0.389 |
| 1 HOUR | 0.307 | 0.328 | 0.322 | 0.210 | 0.202 | 0.201 | 0.231 | 0.259 | 0.256 |
| 2 HOURS | 0.184 | 0.188 | 0.187 | 0.089 | 0.082 | 0.080 | 0.159 | 0.165 | 0.164 |
| 4 HOURS | 0.159 | 0.157 | 0.155 | 0.048 | 0.045 | 0.045 | 0.152 | 0.150 | 0.148 |
| 6 HOURS | 0.135 | 0.125 | 0.124 | 0.043 | 0.040 | 0.039 | 0.127 | 0.118 | 0.117 |
| 8 HOURS | 0.109 | 0.099 | 0.098 | 0.033 | 0.027 | 0.027 | 0.103 | 0.094 | 0.093 |
| 12 HOURS | 0.106 | 0.095 | 0.096 | 0.030 | 0.024 | 0.023 | 0.101 | 0.092 | 0.093 |
| 24 HOURS | 0.102 | 0.093 | 0.093 | 0.021 | 0.012 | 0.013 | 0.099 | 0.091 | 0.092 |

From Table 2, it can be concluded that having more data improve the accuracy of PPP solution, in all components (3D, 2D and height).

From an ephemeris perspective, in general, final ephemeris performs better than rapid and ultra-rapid ephemerides while rapid ephemeris performs better than ultra-rapid ephemeris. There are cases where rapid ephemeris performs slightly better than final ephemeris or worse than ultra-rapid ephemeris, but the difference is not big and can be attributed to random errors in processing and data analysis.
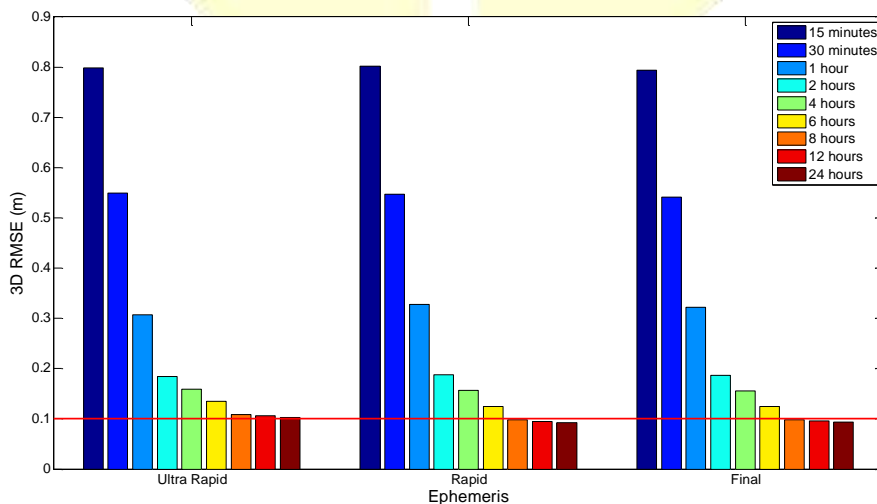


**Figure 3** 3D accuracy of PPP solution using different ephemerides with varying duration of data.
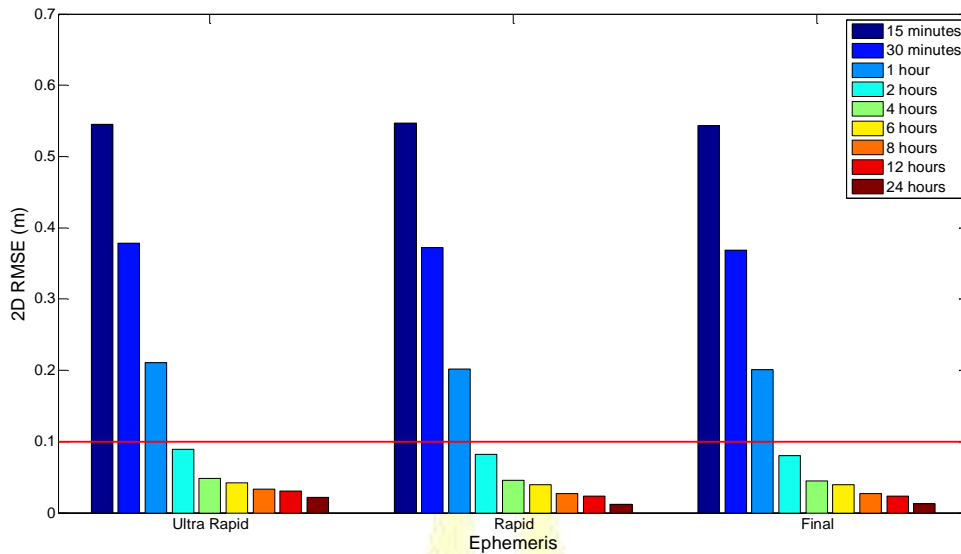
**Figure 4** 2D accuracy of PPP solution using different ephemerides with varying duration of data.
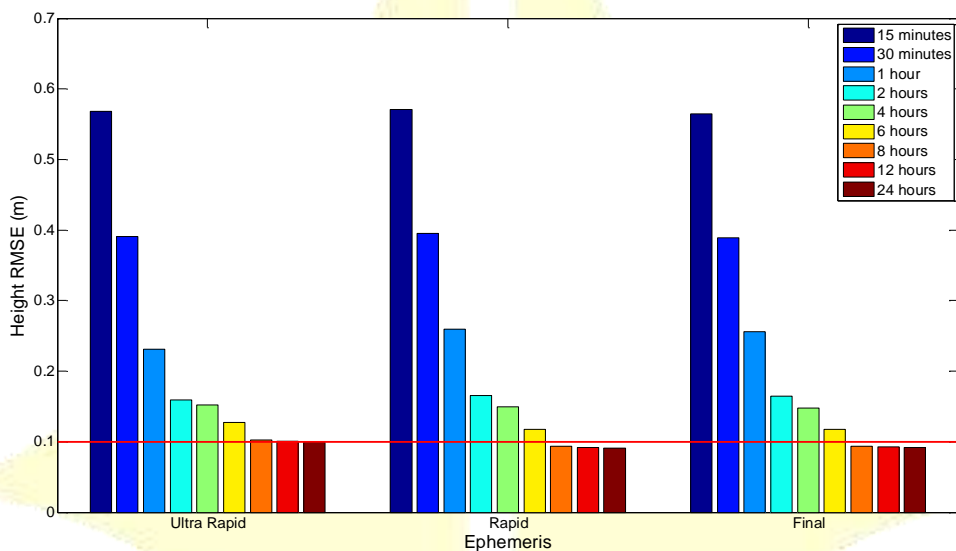


**Figure 5** Height accuracy of PPP solution using different ephemerides with varying duration of data.

## CONCLUSION

Different ephemerides with varying duration of GPS measurement data are used to assess the accuracy of PPP in Malaysia. The accuracy of PPP increases when the duration of data increases for all types of precise ephemerides. Decimeter accuracy can be achieved in all components (3D, 2D and height) by all precise ephemerides using when using the minimum 15 minutes data. 3D sub decimeter accuracy can be achieved by using 8 hours of data for rapid and final ephemerides, 2D sub decimeter accuracy is achieved using 2 hours of data for all precise ephemerides while height sub decimeter accuracy was achieved by using 24 hours data for ultra-rapid ephemeris and 8 hours data for rapid and final ephemerides.

This study can be improved by using data spans that is longer as the current experiment only used one day data. In addition, broadcast ephemerides can also be processed using PPP to provide a better understanding between broadcast and precise ephemeris for PPP

processing. Besides that, the duration of data can be shorten to determine the minimum data duration required for PPP to achieve decimeter accuracy in Malaysia. Current minimum duration of 15 minutes is not the absolute minimum duration of data required for PPP to achieve decimeter accuracy in Malaysia.

PPP can be used as a processing technique to quantify the impact of ephemerides in a region (Lee et al., 2023). With this study, it has shown that 15 minutes of data is sufficient for PPP to achieve decimeter accuracy in Malaysia, and can be further used as the minimum duration of data for further analysis involving ephemerides.

## ACKNOWLEDGEMENT

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# CHALLENGES AND OPPORTUNITIES OF GEOLOCATION APPLICATION IN AGRICULTURE: A SCOPING REVIEW

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## ABSTRACT

Agriculture 4.0 has mostly been defined in terms of production and environmental advantages, with little emphasis focused on social sustainability as it employs information and communication technologies with the goal of enhancing agricultural yields. Nowadays, artificial intelligence (AI), sensors, remote sensing, and geolocation technology are used in agriculture that support towards financially viable, efficient, safe, and ecologically friendly. Hence, this paper aims to review on the challenges and opportunity of the geolocation application in agriculture. This scoping review is focusing on the extensive overview of geolocation technology opportunities and challenges in the agriculture industry. Geolocation application in agriculture industry makes use of mobile positioning technology with the ultimate intention of impowering farmers in smart farming. Despite the opportunities of the geolocation applications in agriculture, there are also other downside that may affect the efficiency of this technology.

*Keywords: Geolocation, Mobile, Positioning Technology, Agriculture 4.0*

## INTRODUCTION

Agriculture is a work or an activity that includes crop and animal production, aquaculture, fisheries, and forestry for food and non-food goods. The agricultural industry is confronted with critical global difficulties such as climate change, urbanisation, resource sustainability, and environmental concerns as these scenarios are compounded further by the increasing demand for food that would be required to maintain an expected population expansion from 6 billion to 9 billion by 2050 (Chiralt and Balestra,

2019). Agriculture 4.0, a term inspired by Industry 4.0, seeks to address these difficulties by integrating cross-industry technology and applications. Agriculture 4.0 makes use of information and communication technology with the ultimate intention of increasing crop yields (Fitzek et al., 2020). Artificial intelligence (AI), sensors, remote sensing, and mobile geolocation technologies will be fully use in agriculture in the near future since they are able to empower the agribusiness activities in sustainable and effective environment (Oliver Wyman, n.d.). Therefore, this paper addresses on the

implementation of mobile geolocation technologies in the agricultural sector.

Geolocation is the method of locating, determining, and transmitting the accurate location of a computer, networking device, or piece of equipment in which offers the gadget to be located using geographical coordinates and mobile positioning technologies (Frankenfield, J., 2021). There are many mobile positioning technologies that relies on GNSS, A-GPS and wireless communication such as broadband data from cellular network and Wi-Fi including short range wireless connectivity such as from Bluetooth, Near-field communication (NFC), and RFID (Dardari et al., 2015). Every year, multiple innovations are used by various scientists, agronomists, and technologists to boost agricultural productivity while minimising environmental damage. One of those innovation is precision farming which is the study of the application of technology to enhance agricultural practises in comparison to traditional agricultural methods while offering a reduced negative impact on the nature (Goswami et al., 2012). According to Mehta et al., (2020), the geographic information system (GIS) established by the computational background allows for the generation of sophisticated views of fields and the making reliable agricultural technical decisions as farmers now have the capacity to take into consideration for geographical heterogeneity thanks to the satellite-based global navigation satellite system (GNSS).

Mathenge et al. (2022) have provide systematic reviews on the implementation of GIS and Remote Sensing (RS) application in agriculture for improving evidence-informed policy and practise and identifying barriers to its implementation. Nevertheless, that study did not focussing on the opportunity of mobile geolocation in agriculture, due to the capability to empower farmers in smart farming, hence there is a gap that need to be addressed. On the other hand, the study by Pratt et al., (2020) review on the potential and challenges of geo-agriculture which focussing more on geological material rather than geolocation. There is lack of potential and challenges of geolocation application in agriculture. Therefore, the purpose of this paper is to review on the challenges and opportunities of the mobile geolocation application in agriculture sector since the increasing use of global navigation satellite system (GNSS) with other mobile positioning and wireless technologies for data aggregation and precision farming.

## MATERIAL AND METHOD

This scoping review structure was adapted by Levac et al. (2010) based on the research of Arksey and O'Malley (2005). According to Arksey and O'Malley (2005), the scoping study approach is directed by a necessity to find any relevant literature independent of study design rather than by a highly focused research issue that lends itself to looking for specific study designs. Therefore, the purpose of this study is to review on the challenges and opportunities of the geolocation in agriculture. The methodology is divided by five stages which are determining the research question; determining relevant studies; study selection; charting the data; collating, summarizing, and reporting the results.

For the first stage of this research, which is to identify the research question, it is supposed to set criteria based on the range and quantity of references produced. In order to ensure breadth of coverage in the search, Levac et al. (2010) suggest maintaining a broad search strategy with clearly defined concepts and their continuous refinement after beginning with broad definitions for the research population, interventions, or outcomes. There are three questions that have been identified in this paper. 1) What are the agricultural innovations that make use of geolocation's technologies? 2) What is the opportunity for geolocation in the agriculture sector? 3) Lastly, what are the challenges of geolocation technology in agriculture?

The second stages in which identifying relevant studies include the locating primary works (both published and unpublished) and reviews that are appropriate for addressing the main research issue. This study used a technique that includes looking for research evidence throughout several sources. Three databases were chosen, and the search has been done through Scopus, Science Direct and ProQuest. The search was conducted using a thorough search strategy that included the keywords of the abstract related in which geolocation, mobile, application development, and agriculture together with the Boolean operators OR and AND as in Table 1. Other than that, there is also limitation to English languages and

duration of 10 years article. In the third stage, relevant papers were chosen, and they were screened based on the title, abstract, and full text.

As for the stage four, the article chosen from stage three will be analysed in which the information that are being included are innovation or techniques of agriculture, opportunities, and challenges. Then, the analysed information from stage four will be used in the stage five to collating, summarizing, and reporting the results. Figure 1 shows the flow process for study selection using preferred reporting items for systematic review.

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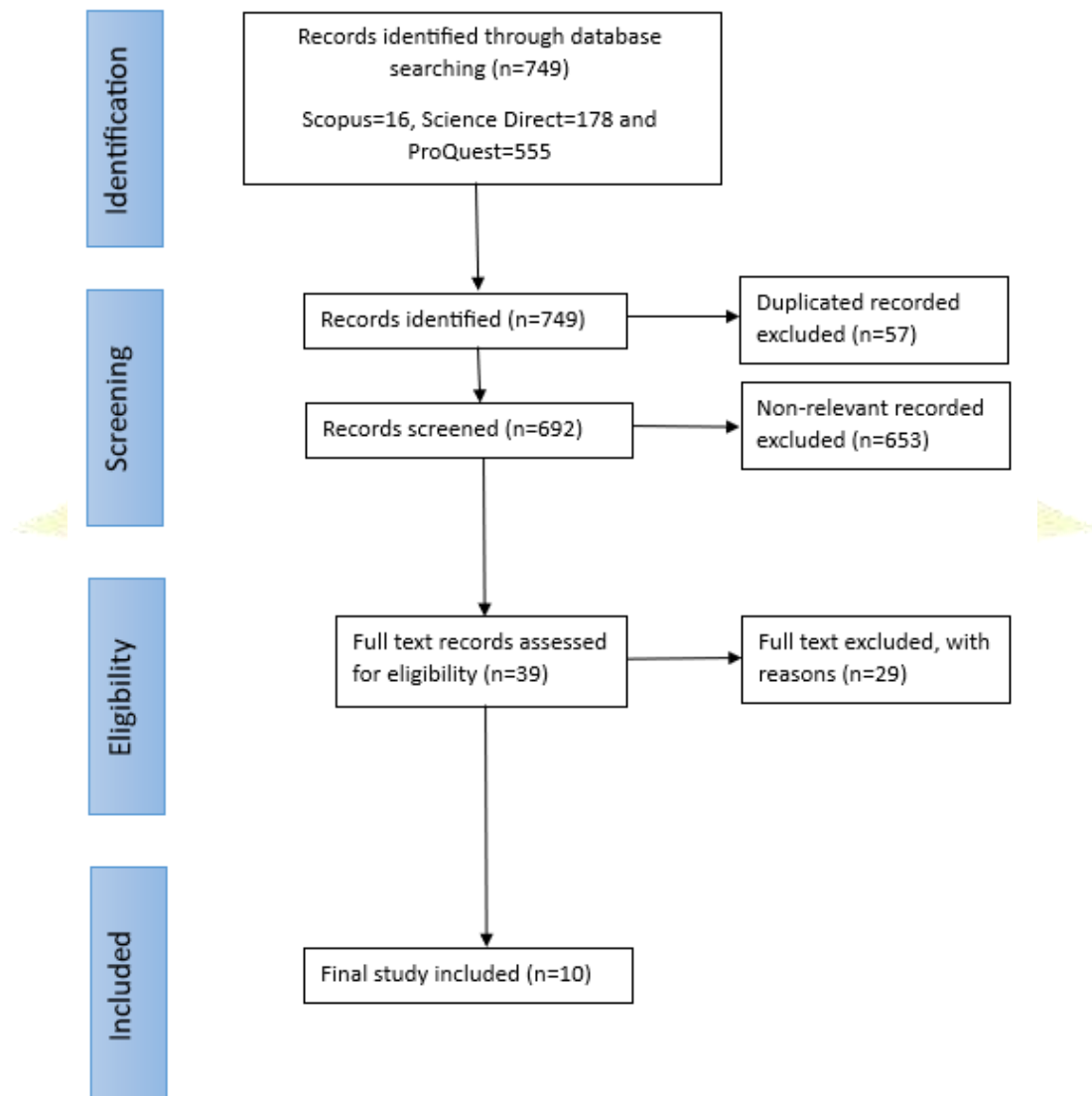


**Figure 1** Flow Process For Study Selection Using Preferred Reporting Items For Systematic Review

Table 1 Search String used in Scopus, Science Direct and ProQuest

| Research Components | Research Terms (keywords research) |
|---|---|
| #1 Geolocation | "geolocation" OR "geographical location" OR "geopositioning" |
| #2 Application and software development | "application development" OR "software development" |
| #3 Mobile | "mobile" OR "mobile location-based services" OR "mobile GIS" |
| #4 Agriculture | "agri" OR "agriculture" |
| #5 Combination | #1 AND #2 AND #3 AND #4 |

## RESULTS AND DISCUSSIONS

According to Figure 1, there are a total of 749 articles acquired via database search. 57 articles were eliminated as a result of duplication, 653 were removed based on their titles and abstracts, and 29 were removed after a thorough assessment. As a result, 10 papers were chosen for inclusion in this scoping review utilising preferred reporting as described by Shamseer et al. (2015).

## Geolocation in Agriculture Management Approaches

With the development of science and technology, the application scope of geolocation in agriculture is getting wider and wider. According to the finding of this scoping review, there have been several agricultural management approaches that apply innovation via geolocation technology. Those approaches include precision agriculture (Lamb et al., 2022; De Araujo Zanella et al., 2020; Wachowiak et al., 2017; and Chamara et al., 2022), plant breeding (Onsongo et al., 2022), sustainable agriculture (Sugianto et al., 2021; and Zhou & Li, 2021), agriculture system modelling (Janssen et al, 2017), agricultural fleet management (Huuskonen & Oksanen, 2019), and livestock production system (Eastwood et al., 2021). Precision agriculture, also known as precision farming, is an innovative management technique based on georeferenced information for food production control that is based on the elaboration of georeferenced information through the use of tracking techniques and the incorporation of soil, plant, and climatic characteristics (Gomiero, 2019). Plant breeding, on the other hand, is an innovative technique for modifying the genetic pattern of plant species to boost their worth and benefits for human welfare. As for sustainable agriculture, it involves the effective management of ecological biodiversity that could be used to meet human requirements while protecting natural resources (Ray et al., 2022). Next, agricultural system models are methods that give an overview and assessment of the impacts of water, soil, crops, management practises, and climate on crop sustainability and food security (Ahmed et al., 2022), while agricultural fleet management is a significant field of study that deals with resource allocation, operation scheduling, routing, communication, and real-time data collection (Wu et al., 2020). According to Pandey & Upadhyay (2022), the livestock production systems, which are generally a subset of agriculture, are the consequence of agro-ecological factors combined with human beings' constant and purposeful effort to harness diverse commodities and services towards meeting their various types of requirements.

From the search in this review identifies, countries that emerged to apply geolocation technology are Indonesia,

Brazil, New Zealand, United States of America, China, Finland, and Canada (Table 2). Based on the Table 2 below, precision agriculture is the most frequent approach that used geolocation applications and mostly in USA.

**Table 2** Geolocation Applications according to Agricultural Manage

| Publication | Approaches | Country | Geolocation Application |
|---|---|---|---|
| Lamb et al. (2022) | Precision Agriculture | Brazil | Mobile device application that creates a pathway for the location of georeferenced sample locations by inputting text data |
| Sugianto et al. (2021) | Sustainable Agriculture | Indonesia | GIS technology for land use management and sustainable agriculture mapping |
| De Araujo Zanella et al. (2020) | Precision Agriculture | Brazil | Digital revolution which consists of sensors, GPS, RFID tags, cameras, actuators, and any other equipment that capable of gathering data from a farm environment |
| Huuskonen & Oksanen (2019) | Agricultural Fleet Management | Finland | Augmented Reality (AR) for supervising multirobot system |
| Onsongo et al. (2022) | Plant Breeding | United States of America | Integrated Tool for AgData Lat Long Imputation and Cleaning (ITALLIC) |
| Eastwood et al. (2021) | Livestock Production System | New Zealand | Commercial application like sensors for data capture, automation and robotics, IoT, cloud computing and data analytics |
| Janssen et al. (2017) | Agriculture System Modelling | United States of America | NextGen application, an agricultural system |

| | | | that assist firms, governments, and farmers in decision making |
|---|---|---|---|
| Wachowiak et al. (2017) | Precision Agriculture | Canada | GeoVisage, an agriculture producer that offer decision-making tools |
| Chamara et al. (2022) | Precision Agriculture | United States of America | Ag-IoT systems allow an innovative agricultural information pipeline |
| Zhou & Li (2021) | Sustainable Agriculture | China | Web GIS-based tropical agricultural pesticide application ecology and security surveillance system |

## The Opportunity of Geolocation Applications in Agriculture

In the realm of modern agriculture, geolocation applications have emerged as a promising frontier. Leveraging GPS and geospatial technology, these applications offer unprecedented opportunities to enhance precision, optimize resource utilization, and ultimately revolutionize farming practices. There are four opportunities that will be discussed in this section which are field data collection, big data analysis, land use mapping and planning, and minimize time and ease of work.

### Field Data Collection

There are several opportunities that geolocation technologies hold in the agricultural industry that benefit consumers and developers. According to the study by Lamb et al. (2022), the accuracy of a device can potentially be employed in data collection operations for precision agriculture, particularly when dealing with zoning management. In their research, they develop SNAC (System for Navigation in Field Activities) that

functions to support farmers and service providers in keeping records of georeferenced sample places and enable them to navigate their location to the field using optimised routing strategies based on mobile device resources. The SNAC system is indeed a functional tool for precision agriculture since precision agriculture depends on specific software, tools, and GIS technology services. This includes real-time data on agricultural products, the ground, and ambient air conditions, as well as other essential data such as hyperlocal weather forecasts (Wigmore, 2022). Therefore, the deployment of mobile GIS technology will increase agricultural productivity while also providing farmers with better data accuracy solutions.

### Big Data Analysis

This scoping review found that geolocation technology is capable of combining a set of data from across the country to form a big data analysis that can present that information to consumers in the form of data and images for monitoring (Zhou & Li, 2021). More data and improved

technology lead to more accurate and proactive decision-making, as well as more productive and pleasurable workplaces (Eastwood et al., 2021). Mobile phones, GPS, and tablet devices function as sensors or instruments that could upload data to the internet, including precise position and time information, which is viewed as a potential option for close sensing (Janssen et al., 2017). While these devices and sensors are becoming more user-friendly, they remain fragmented due to conflicting interests. Additionally, the diversity of data formats, the velocity of data flowing off of many devices, and the quantity of data created have resulted in a fragmented and siloed agricultural data management architecture (Delgado et al., 2019b). In context, this is a big data challenge that need to consider, which is a mix of different types of data, data velocity, and data volume.

### Land use Mapping and Planning

Geolocation applications are indeed useful in land use mapping, as the utilisation of maps and satellite imagery as a data source is one factor to consider in order to reach global development goals in an effective and efficient manner. This statement is proven by the study of Sugianto et al. (2021), which stated that complete and spatially precise data will increase the quality of local and national development. Based on their study, geospatial technology is an essential tool for land use planning and sustainable agricultural mapping since there is a need to accommodate the need for agricultural operations in Aceh province. Therefore, the agricultural sector must be equipped with long-term land use monitoring solutions, beginning with remote sensing by employing drones for cost-effective, efficient, and rapid agriculture mapping. It is because, drones with cameras can generate high-resolution maps of fields in which this data may be used to detect problem regions, track crops, and estimate production possibilities (Hoummaidi et al., 2021),

### Minimize Time and Ease of Work

Geolocation systems ease and reduce labour time and costs. A study by Huuskonen & Oksanen (2019) resulted in increasing situational awareness of the human operator with the help of a system that employs wearable Augmented Reality and geolocation technology. Other than that, a study by Onsongo et al. (2022) determined that geolocation also minimises the amount of time needed to clean location-based plant breeding data for integration by automating the process of discovering and fixing errors and by offering a visualisation interface that allows users to spot possible issues quickly and easily. These studies promote the usability and potential of geolocation applications in agriculture, which will save users energy and time. Both studies are in line with the food delivery services that offer customers time and energy savings, such as GrabFood and FoodPanda. According to Shuhaimi et. Al (2021), food delivery services could make daily lives easier, and on-demand food systems can save customer's time.

## The Challenges of Geolocation Applications in Agriculture

While geolocation applications hold immense promise in agriculture, they are not without their challenges. As the agricultural industry embraces digital transformation, it grapples with issues related to power supply and internet connectivity, user adaptation and readiness towards technology, and accuracy and privacy issues.

### Power Supply and Internet Connectivity

There are a few challenges that have been identified through this review of the geolocation system in agriculture for consumers. Geolocation applications

embedded with GNSS technology lead to power supply drainage. According to the study by Huuskonen & Oksanen (2019), the geolocation instrument or device needs a sufficient power supply in order to ensure the system runs smoothly. Chamara et al. (2022) also stated that power management and device longevity are crucial issues in their study. Given that most farms are in rural areas, isolated locales, or mountain regions, getting internet access to them is a big difficulty because these underpopulated areas have little internet infrastructure (Chamara et al., 2022). The most frequent challenges that occur in geolocation applications for agriculture sector are battery drain, while internet connectivity problem always occur in rural areas. This statement is in accordance with the navigation application. There is a groundbreaking mapless driving framework in rural areas that blends sparse topological maps for worldwide navigation with a sensor-based perception technique for regional navigation (Ort et al., 2018). Other than that, employing GNSS device solutions may quickly drain the device's battery in navigation applications when the mobile location is turned on and cause the mobile to heat up.

## User Adaptation and Readiness Towards Technology

The challenges for the implementation of geolocation applications in agriculture are mostly related to stakeholders' acceptance (i.e., farmers, industries, and governmental sectors) and convincing them that the developed system could reduce their workloads and optimise their agriculture operations. The readiness of human resources and technologies (Sugianto et al., 2021) is one of the crucial issues, as there is a concern about increasing consumer impressions of industrialised farming, separation from traditional animal husbandry and the purpose of being a farmer, and the

commercialization of farm data (Eastwood et al., 2021). There are concerns about the adaptation of the user towards new technology, especially given the large geographical area of the research area and the cost of user training (Wachowiak et al., 2017). The concern of these articles is relevant because the user adaptation and readiness of geolocation technology will result in extensive economic and societal impact. Therefore, in order to accomplish future operational achievement with geolocation application, human adaptation, procedure, and human readiness are necessary, along with technological readiness (Uren & Edwards, 2023).

## Accuracy and Privacy Issues

The data and information retrieved by the geolocation app and supplied by the end users (farmers) might also lead to inaccurate coordinates, as stated by Onsongo et al. (2022), who stated that there could be mistakes in location data, such as reversed latitude and longitude values, missing negative signs, and, in some cases, missing data. However, there is a lack of challenge in using GNSS in those study. The dependability, precision, and accessibility of GNSS are vital, particularly for critical and precise positioning applications. Even so, space transmissions are weak and frequently obstructed, interrupted, or damaged by a variety of additional challenges (Xu et al., 2020). For instance, surrounding structures may block and reflect satellite signals, GNSS location in urban environments at this point does not deliver precise and accurate performance.

On the other hand, keeping privacy, maintaining trust and reliability are vital in fulfilling the demand and guarantee of developing applications (De Araujo Zanella et al., 2020) such as location information of the users. The challenges stated by De Araujo Zanella et al. (2020)

should be consider by the developer. In the context of farmer-developer collaborations, developers might appear cautious about releasing data belonging to the farmer because of challenges with confidential software and hardware. Farmers might be unable to access, let alone share, their own data. Furthermore, "dual ownership" of data might generate uncertainty in collaborative research (Moore et al., 2021). Hence, in order to minimise such issues, this paper recommends developing data management strategies and information access agreements right before the start of projects.

## CONCLUSION

In conclusion, this scoping review examined the role of geolocation technology in agriculture management. Out of a total of 749 articles, 10 were selected for inclusion in this review following a rigorous screening process. The study revealed that geolocation technology has found application in various agricultural management approaches, including precision agriculture, plant breeding, sustainable agriculture, agricultural system modeling, agricultural fleet management, and livestock production systems. These approaches utilize georeferenced information to improve farming practices, boost crop yields, and enhance ecological sustainability.

The review also identified countries at the forefront of geolocation technology adoption in agriculture, including Indonesia, Brazil, New Zealand, the United States of America, China, Finland, and Canada. Among these countries, precision agriculture emerged as the most prevalent approach employing geolocation applications, with a notable focus in the USA.

Furthermore, the review highlighted four key opportunities presented by geolocation applications in agriculture.

These opportunities encompassed field data collection, big data analysis, land use mapping and planning, and efficiency improvements. Geolocation technologies offer the potential to improve data accuracy, enhance decision-making through big data analysis, support land use planning, and streamline agricultural operations, ultimately saving time and reducing labor costs.

However, alongside these opportunities, the review also highlighted several challenges associated with geolocation applications in agriculture. These challenges included power supply and internet connectivity issues, user adaptation and readiness toward technology, and concerns regarding data accuracy and privacy. Addressing these challenges is crucial for the successful implementation and widespread adoption of geolocation technology in agriculture.

The sources of articles found in this review are not enough to cover the agricultural sector since agricultural scope are too big. Therefore, this paper recommends adding more library databases to get more relevant articles and narrow down the agricultural scope, such as on crops or livestock.

In conclusion, geolocation technology offers immense promise in revolutionizing modern agriculture, but its effective utilization requires concerted efforts to overcome the challenges and harness its full potential for the benefit of the agricultural industry and society at large

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# DATA STRUCTURES AND EXCHANGE FORMATS FOR UNIFIED 3D SPATIAL DATA MODELING: AN OVERVIEW

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## ABSTRACT

The development of 3D spatial data models has been fueled by the expanding availability of 3D data and the rising need for 3D analysis and modelling. The core of a 3D spatial data model is its data structure and exchange formats. There are many benefits to using data structures and exchange formats, including improved data organization, more effective data storage, flexibility in the level of detail, improved data interoperability and exchange, improved representation, and support for a range of data analysis and modelling tasks. However, there is still uncertainty over the data structure and accepted format for combining surface and subsurface spatial objects in a 3D geographic data model. Consequently, this work examines the prospects and limitations of integrating surface and subsurface spatial objects into a 3D spatial data model using data structure and standard formats. The results demonstrated the benefits of the exchange format and data structure for 3D spatial data modelling. However, integrating 3D spatial data models of surface and subsurface objects is still challenging. Hence, additional research on data structures and exchange formats is required to create a unified 3D spatial data model of the surface and the subsurface. The findings will aid planning, design, infrastructure, facility services, and visualization processes. Additionally, it will improve environmental management, new facilities construction, and prevent damage to utility lines when excavating.

*Keywords: Data Structures, Exchange Formats, Integrated 3D Spatial Modeling, Surface Objects, Subsurface Objects.*

## 1.INTRODUCTION

In recent years, 3D spatial data modelling has experienced an exponential growth due to the demand for accurate representations of complicated real-world scenarios. These models enable improved planning and decision-making by integrating data and applications across the city system (Willenborg et al., 2018). 3D spatial data model is crucial for supporting urban planning, environmental monitoring, and catastrophe management applications. According to Adouane et al. (2021), it is feasible to develop new

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facilities, better manage the environment, and avoid harming utility lines during excavation that might otherwise cost money by using 3D spatial modelling of surface and subsurface spatial objects. The interaction of the data structure and interchange format yields 3D spatial models. To achieve a consistent representation of spatial objects, efficient data structures and exchange formats for 3D spatial data models are required.

The delivery of best practices, however, is not without its challenges, particularly when various spatial objects are required to create a single 3D spatial data model. The adaptability and compatibility of the data structure, the type of representation (model style and data size), the standards of the exchange format, and the complexity of the infrastructure are among the other difficulties (Nguyen-Gia et al., 2017). For instance, the CSG model style is inappropriate for modelling objects with irregular geometry. The shortcomings of alternative modelling approaches can also be used to explain the flaw in 3D spatial data models.

This paper reviews the data structures and exchange format for unified 3D spatial data modeling especially in surface and subsurface objects.

## 2. DATA STRUCTURES AND EXCHANGE FORMATS FOR 3D SPATIAL DATA MODELING

The effective description and organization of 3D geographic data requires the use of trustworthy data structures and exchange formats. These technologies support effective data sharing and analysis by ensuring seamless communication and compatibility across diverse software and systems. Geospatial professionals can overcome challenges brought about by the complexity of 3D data by utilizing dependable data structures and defined exchange formats. This approach enables comprehensive understanding and informed decision-making in various applications, from urban planning to environmental monitoring. In an urban setting, 3D city models provide a

trustworthy and widely accessible virtual representation of real objects. The models also act as an integration platform for data and applications related to the city system (Willenborg et al., 2018). In data organization, there must be a balance between the necessity of establishing a connection between data structure and exchange formats. In this section, the discussions are divided into 3 which are: overview of 3D spatial data structures and exchange formats, current data structures and exchange formats and application of data structures and exchange formats.

## 2.1 OVERVIEW OF 3D SPATIAL DATA STRUCTURES AND EXCHANGE FORMATS

Spatial data structures are critical tools for storing and organizing geographic information for easy access and analysis. Numerous applications, such as robotics, computer graphics, geographic information systems, among others depend on spatial data structures. . Specialized data structures simplify access and manipulation of geographic data, enabling spatial analyses, simulations, and navigational algorithms, supporting geospatial advancements in multiple dimensions. Additionally, data structures are abstractions intended to efficiently implement data (Howari and Ghrefat.,2020). Several spatial data structures facilitate the 3D modeling of spatial objects for various applications. These include Format Data Structure (3D-FDS), Tetrahedral Network (TEN), Object Oriented Model (OO Model), Simplified Spatial Model (SSM), Solid Object Management System (SOMAS), Urban data Model (UDM, EUDM, LUDM), object Oriented 3D (OO 3D), 3D arrays Model, Octree Model, V3D model. **Table** 1 presents an overview of the various data structures and exchange formats for organizing and representing 3D spatial data as adapted by Tuan. (2011). According to the author, there are various data structures and model styles that can be used for representing different spatial

objects. Additionally, these indicate classifications under boundary representation (BREP), voxel, constructive solid geometry (CSG) and combinatorial. Other spatial data structures for 3D spatial objects that may have been developed could be categorized as belonging to any of the modelling approach or classification 3D spatial data models utilize various exchange formats, including international standards (VRML, X3D, IFC, CityGML), vendor-approved standards (KML), and de-facto standards (SHP, DXF, COLLADA, 3D PDF). The file formats were developed for certain purposes (for example, SHP includes geometry and

attributes), VRML (allows realistic visualization and interaction), COLLADA (supports modeling and visualization), and IFC (keeps semantics along with geometries) (Zlatanova et al., 2012). Frith & Watson.(2017) observed that recognizing and maintaining standards is crucial for consistent data gathering and retention among stakeholders.

**Table 1:** Data Structures and Exchange Formats for 3D Spatial Data

| Model Style | References | Model | Surface representation | Objects inside representation |
|---|---|---|---|---|
| BREP | Molenaar (1990) | 3DFDS | Non triangular | No |
| | Pilouk (1996) | TEN | Triangular | Yes |
| | Zlatanova (2000) | SSM | Non triangular | No |
| | Delalosa (1999) | OO | Triangular | Yes |
| | Pfund (2001) | SOMAS | Non triangular | No |
| | Coors (2003) | UDM | Triangular | No |
| | Shi et al. (2003) | 00 3D | Triangular | Yes |
| | Groger (et al. 2007) | City GML | Triangular | No |
| Voxel | NULL | 3D Array | Non triangular | Yes |
| | Meagher (1984) | Octree | Non triangular | Yes |
| CSG | Samet (1990) | CSG | Non triangular | Yes |
| Combination | Xinhua et al. (2000) | V-3D | Non triangular | Yes |
| | Chokri et al. (2009) | B_REP + CSG | Non triangular | No |

## 2.2 CURRENT DATA STRUCTURE AND EXCHANGE FORMATS

It is essential to arrange data and their various exchange formats in order to examine how they function and possibly modify them for increased effectiveness. Despite the abundance of data structures that are accessible in

various fields for a variety of applications, the data structure for the 3D representation of spatial objects must be evaluated in terms of the representational style. **Table 2** presents a summary of previous 3D GIS data structures and compares them based on several criteria by (Nguyen-Gia et al. ,2017).
However, it does not examine each data

structure in depth or evaluate how well it works in practical contexts. While emphasizing 3D cadastral operations Jaljolie et al. (2018) concentrated on the database, data structure, functionality, and regulatory deficiencies. Vitalis et al.(2019) emphasized that a key component of their suggested method for topologically representing 3D city models is data structure. One of the data structure that has received prominence over the years is the TIN data structure due to its several advantages(Abdul-Rahman& Drummond, 2000), advised that object-oriented TIN-based GIS subsystems be implemented. There are some applications of data structure for 3D models for surface and subsurface integration.

**Table 2:** Comparison of primitive/geometric elements, data size & applications (Nguyen-Gia et al., 2017)

| Models Style | Model name, Primitive elements | Geometry Elements | Foundation | DS | Application |
|---|---|---|---|---|---|
| BREP | 3DFDS, Point, Surface, Body | Node, Arc, Face | 2D GIS | L | 3D UM |
| | TEN, Point, Line, Surface, Body | Node, Arc, Triangle, Tetra | Tetrahedron | L | GA |
| | OO, n-simplex (n =0, 1, 2, 3) | Node, Arc, Face | OO, n-simplex | L | 3D UM |
| | SSM, Point, Line, Surface, Body | Node, Face | OO, Topology | S | 3D WU |
| | SOMAS, Point, Line, Polygon, Solid | Vertex, Edge, Face, Solid | OO | L | 3D UM |
| | UDM, Point, Line, Surface, Body | Node, Pace | Triangular | S | 313 UM |
| | OO3D, Point, Line, Surface, Volume | Triangle, Node, Segment | OO, Triangular | L | 3D UM |
| | CityGML, Point, Curve, Surface, Solid | 'Polygon, Linestring | Object's Standard | L | 310 UM |
| | EUDM, Point, Line, Surface, Body | Node, Face | Object's Shape | VS | 3D UM |
| | LUDM, Point, Line, Surface, Body | Node, Face, LOD | LOD | L | 3D UM |
| | 11-CityGML, Point, Curve, Surface, Solid | Polygon, Linestring | Object's Standard | L | 3D UM |
| | 12-CityGML, Point, Curve, Surface, Solid | Polygon, Linestring | Object's Standard | L | 3D UM |
| Voxel | 3D Array, 3D Array | None | ABVP | VL | GA |
| | Octree, Cube | None | VPOP | VL | GA |
| CSG | CSG, basic 3D block | NULL | Basic 3D Block | S | CAD, CAM |
| COM | V3D, Point, Line, Surface, Body, Raster | Node, Edge, Face | BREP, Raster | L | 3D UM |
| | BREP+CSG, Point, Line, Surface, Body, Basic 3D Block | Linestring, Face | BREP, CSG | L | 3D UM |

## 2.3 SURFACE AND SUBSURFACE INTEGRATION

Previous studies have proposed several methods for the surface and the subsurface. In the study of Duncan & Rahman. (2013), a geometric A geometric, topological 3D object-oriented approach was proposed for integrating surface and subsurface spatial data objects. Their model, however, lacks 3D integration for subsurface objects and offers an inadequate Level of Realism (LoR) in city centres. A framework for integrating surface and subsurface 3D spatial objects into the 3D spatial data infrastructure (3D SDI) based on the CityGML standard was proposed by (Al Kalbani & Abdul Rahman. 2019). Nevertheless, there is a lack of interest in modeling subsurface spatial objects, which is compounded by

concerns and obstacles in data structure. Yan et al. (2019) evaluated the challenges and presented a method for merging 3D objects and terrain in digital twin.3D modeling However, identifying valid intersections between terrain and objects, as well as variance in data set quality, was a restriction to deal with. Similarly, Chen et al. (2018) proposed an improved strategies to achieve the integrated visualization of aboveground and underground 3D spatial objects in a virtual globe-based spherical coordinate. Guo et al. (2012) proposed a unified model that connects 3D topographic objects and geological strata to the digital terrain model (DTM) for 3D terrain modelling as a triangular irregular network (TIN). **Table 3** depicts the summary of previous studies on surface and subsurface integration for several applications.

**Table 3**: Summary of Previous studies on surface and subsurface integration

| Author(s)/Year | Method | Findings | Limitations |
|---|---|---|---|
| (Al Kalbani & Abdul Rahman. 2019) | a framework for combining surface and subsurface 3D spatial objects into the CitGML-based 3D spatial data infrastructure (3D SDI). | Capability to combine data structures for surface and subsurface 3D spatial objects into 3D SDI based on CityGML standards. | Lack of interest in modeling subsurface spatial objects, as well as data structure difficulties and challenges |
| Yan et al. (2019) | method for reliable 3D reconstruction of LOD1 models based on 3D point clouds, DTM, and creating 2D footprints. | The correct approach to creating 3D objects and terrain | The accuracy of data sets and the identification of valid intersections between terrain and objects may vary. |
| Chen et al. (2018) | Framework for integrating and visualizing 3D spatial components aboveground and below ground in a virtual globe-based environment. | Strategies for merging were proposed and to validate the methods, a virtual globe-based prototype system was developed. | There has been little study on the integration and visualization of large-scale subsurface models and objects |
| Duncan & Rahman. (2013) | A geometric, topological 3D object-oriented approach for the integration of surface and subsurface spatial data objects was proposed. | The approach given here may be used to implement 3D GIS for mining and 3D cadastre. | The absence of 3D integration for subsurface objects. |
| Guo et al. (2012) | an integrated model that connects 3D topographic objects and geological strata with the digital terrain model (DTM) for 3D modeling. | To connect terrain and geo-objects, a seamlessly integrated geometrical model is necessary. | The model may not be suitable for other underground spatial objects |

## 3. APPLICATIONS AND USE CASES OF UNIFIED 3D SPATIAL DATA MODELING

Unified 3D geographic data modeling is a versatile and significant tool in various fields, including geosciences, city, and urban planning. It utilizes standardized data structures and exchange formats to enhance analysis, collaboration, visualization, and decision-making. A recommended approach involves using a geometric, topological, three-dimensional object-oriented structure, allowing for the seamless combination of surface and subsurface spatial objects. In geosciences, unified 3D spatial data modeling plays a pivotal role in geological exploration and resource management, enhancing collaboration between researchers and organizations. In city and urban planning, unified 3D spatial data modeling transforms urban landscapes, aiding design evaluations and public engagement. It also benefits transportation engineering and environmental studies by facilitating efficient urban mobility planning and traffic management. To further enhance unified 3D spatial data modeling, potential upgrades to data structures and exchange formats are essential. This includes optimizing data structures, interoperability between different data formats and software systems, and incorporating metadata support for better documentation and integration across multiple projects.

## 4.CHALLENGES AND FUTURE DIRECTIONS

Despite recent advancements, the current data structures and communication formats for 3D spatial data modeling still have limitations. To drive advancements, it

is essential to monitor and embrace cutting-edge developments in data structures, such as optimizing data organization, improving storage efficiency, and facilitating seamless information exchange. Cloud-based solutions and distributed databases can enhance scalability and data accessibility while minimizing latency and storage costs. Integrating artificial intelligence and machine learning techniques can improve data analysis and interpretation. Automated data processing and feature extraction algorithms can accelerate data preparation and enhance model accuracy. Data compression techniques can reduce the storage footprint of 3D spatial data, enabling more efficient data exchange and transmission over networks. Key improvements for data structures and exchange formats include optimizing data structures for efficiency, enhancing metadata support, establishing open standards for interoperability, supporting streaming and real-time applications, and considering big data processing. By staying informed about emerging trends, leveraging new developments in data structures, and embracing open standards for data exchange, we can unlock the full potential of 3D spatial data modeling. Collaborative efforts and innovative solutions will shape the path towards a more connected and informed world.

## 5. DISCUSSIONS

In pursuit of a cohesive and comprehensive 3D data model, a sophisticated data structure is harnessed, capable of effectively representing both surface and subsurface spatial objects. Additionally, a suitable exchange format is adopted to ensure seamless interoperability. Amidst a myriad of available data structures, the Triangular Irregular Network (TIN) structure stands out, lauded for its exceptional advantages over its counterparts. The paramount goal of establishing a unified 3D data model is to harmoniously integrate spatial information, encompassing both surface and subsurface domains. This necessitates a data structure that can adeptly

encapsulate the complexities of spatial objects in three-dimensional space. The chosen data structure must accommodate the inherent intricacies of topography, spatial objects, and other pertinent elements, while preserving the relationships between them. Among the variety of data structures available, the Triangular Irregular Network (TIN) structure rises to prominence due to its exceptional attributes. The TIN approach constructs a network of irregular triangles, ingeniously connecting discrete points through an intricate mesh. This not only ensures a more accurate representation of the terrain but also enables efficient data storage and processing. Moreover, the TIN model facilitates smoother interpolation of data, resulting in heightened precision and realistic visualization. However, while selecting an appropriate data structure is vital, ensuring effective data exchange is equally imperative. Its inherent flexibility allows for the encoding of various spatial attributes, encompassing geometry, semantics, appearance, and more. In conclusion, the pursuit of a unified 3D data model entails the utilization of a powerful data structure, with the Triangular Irregular Network (TIN) structure shining as a standout option.

## 6. CONCLUSION

The paper presented an overview of the data structures and exchange formats for unified 3D spatial data modelling. The development of 3D spatial data models is crucial due to the increasing availability of data and the demand for analysis and modeling. A successful model relies on its data structure and exchange formats, offering benefits such as improved data organization, efficient storage, flexibility in detail, enhanced data interoperability, and representation. This paper explores the prospects and limitations of integrating surface and subsurface spatial objects into a unified 3D spatial data model using data structures and standard formats. The Triangular Irregular Network (TIN) data structure was found to be effective for 3D spatial data modelling. However, challenges remain in optimizing data

structures, ensuring interoperability between formats and software systems, and incorporating metadata support for better documentation and integration. The future direction lies in leveraging cutting-edge technologies like cloud-based solutions, artificial intelligence, and machine learning to enhance data analysis, storage efficiency, and data exchange. Staying informed about emerging trends and embracing innovative solutions can unlock the full potential of 3D spatial data modelling and usher in a new era of efficiency and precision in planning, design, and decision-making processes.

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# ENHANCED DECISION MAKING IN THE BRIDGE INSPECTION PROCESS BY MEANS OF DASHBOARD APPROACH

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## ABSTRACT

Dashboard systems have revolutionized concrete bridge inspection by streamlining the inspection process, improving data analysis, and facilitating informed decision-making. By centralizing inspection data, providing visual representations, and promoting collaboration, these systems enhance the efficiency and effectiveness of bridge inspection and maintenance programs. Embracing dashboard systems in concrete bridge inspection systems is a significant step toward ensuring the safety and longevity of our critical infrastructure. This paper proposes a novel approach for monitoring the bridge inspection different data based on physical inspection data, geomatics and vibration data with concrete bridges as a case study and to have a quick and overall insight into the beginning of the inspection process. The system will use a dashboard that is a combination of charts. This dashboard will enable the (structural) to have all information on the structural behavior of a series of data proposals and make informed inspection decisions based on the compact dashboard.

*Keywords : Concrete Bridge Structure, Data Visualization, Decision-making and Dashboard Approach.*

## INTRODUCTION TO DATA DASHBOARD FOR BRIDGE INSPECTION

A data dashboard is a visual data presentation tool that consolidates and organizes information from various sources into a single, easily accessible interface. It allows users, such as bridge inspectors, engineers, and decision-makers, to quickly grasp the current status and performance of the bridge infrastructure. The dashboard uses various data visualization techniques, such as charts, graphs, maps, and tables, to represent complex data in an understandable format. By providing real-time updates and interactive features, data dashboards enable users to monitor trends, identify patterns, and make informed decisions (Wu et al., 2022).

Dashboard systems have revolutionized concrete bridge inspection by streamlining the inspection process, improving data analysis, and facilitating informed decision-making. By centralizing

inspection data, providing visual representations, and promoting collaboration, these systems enhance the efficiency and effectiveness of bridge inspection and maintenance programs. With bridge inspection data and increasing technologies that allow the storage of bridge inspection data in a neat, structured, and allows displayed in a bar graph to filter the information into a summary form for further action to be taken. To make fact-based decisions, Public Works Department (PWD) bridge inspectors need the bridge inspection data, showed reliably, in an easily accessible and the most typical for this is in the form of a bar graph comparing years of bridge inspections. Concrete bridge inspection data is based on the physical inspection data of PWD officers referring to the rating card for the bridge structure.

Nowadays, the development of technology is moving fast and too much data is observed, monitored and checked to manage data storage and data presentation has led to the proliferation of dashboards. With data dashboards, organizations consolidate inspection data in one place, usually accessed through a web browser. Dashboard content may be tables, graphs or visual key performance indicators (KPIs). This dashboard will enable the (structural) to have all information on the structural behaviour of a series of data proposals and make informed inspection decisions based on the compact dashboard Pappas & Whitman, (2011).

In this paper, a new approach presented graph dashboard. This dashboard represents the overall behaviour and performance of bridge structural alternatives and allows bridge structural inspection data to be stored neatly for year-to-year analysis. This approach, will be illustrated based on a concrete bridge case study. This dashboard aims to offer experienced bridge inspectors an overall synthetic view, while not reducing the behaviour of concrete bridges to a single number. These is part of ongoing research and has the main focus to describe the

methodology to compare the annual bridge inspection data in the structural items in the bridge.

## BRIDGE INSPECTION PROCESS – DATA DASHBOARD CATEGORIES

The bridge inspection process is a crucial activity undertaken by engineers and inspectors to assess the condition, safety, and overall health of bridges. To streamline this process and effectively manage inspection data, a data dashboard is employed. The data dashboard serves as a visual representation of key information and metrics related to bridge inspections, providing a comprehensive overview of the bridge's condition and performance Alessio Pipinato, (2021).

The data dashboard categories refer to the specific types of information and metrics that are included in the dashboard to assist in managing the bridge inspection process effectively. These categories encompass critical aspects such as bridge identification details, inspection ratings, structural health assessments, maintenance history, safety hazards, traffic data, environmental influences, cost estimates, compliance with standards, trends and analysis, geospatial representation, inspection team performance, safety compliance, mobile inspection data integration, and real-time alerts and notifications Campbell et al., (2016).

The bridge inspection process involves a systematic evaluation of various components and elements that constitute a bridge's structure. These components typically include the bridge deck, superstructure (girders, beams, and trusses), substructure (piers, abutments), expansion joints, bearings, and other critical elements. The inspections aim to identify any signs of deterioration, damage, or safety hazards, as well as assess the bridge's load-carrying capacity and remaining service life. Inspections are

typically conducted by trained engineers and inspectors, and they follow standardized protocols and rating systems to ensure consistency and accuracy.

A successful dashboard must have a direct link to the geomatics observation with bridge physical inspection must present data efficiently and provide a way for users to take action based on the data presented. However, critical vibration data activities monitored are different according to the role of bridge inspectors in PWD.

To determine what makes a dashboard visual effective, must understand each structural item displayed along with monitoring data on whether to use it and for what purpose. Determining the structural item in question, we can anticipate the level of damage as well as the action required and the type of measure or category related to that role.

From the purpose, we can obtain categories of data, physical data or physical inspection, and bridge monitoring technique with GNSS and accelerometer, which must be presented among other sources.

## DATA DASHBOARD CATEGORIES - PWD PHYSICAL INSPECTION

Dashboards are now widely used for monitoring and analyzing large amounts of data Kintz, (2012). However, the dashboard for bridge inspection is still in the test run stage because there are rules and practices in bridge physical inspection by PWD officials. In designing and using the dashboard, it also studied how to enter data regularly in the correct order of bridge physical inspection in the field. From an information visualization point of view, the display on the dashboard provides an overview of the value in the form of a graph that shows the level of inspection evaluation on the bridge structure.

## DATA DASHBOARD CATEGORIES – BRIDGE

## MONITORING TECHNIQUE WITH GNSS AND ACCELEROMETER

An additional method in the implementation of appropriate methods for data acquisition and analysis is to detect the normal behaviour of undamaged and damaged structures. Through data acquisition by using the GNSS, there are more than 20 station points established on this bridge and marked for further observation to collect data on the piers between the slabs parallel and observed simultaneously with the fast static method.

## CASE STUDY: BRIDGE TYPE AND SPAN RANGE

The various structural configurations and designs that bridges can take where each bridge type possesses unique characteristics, engineering principles, and load-bearing capabilities. Common types of bridges include arch bridges, beam bridges, truss bridges, suspension bridges, cable-stayed bridges, and cantilever bridges, among others. Each type serves specific purposes and is selected based on factors such as location, traffic volume, available resources, and environmental considerations Lin & Yoda, (2017).

Sg. Perak Reservoir Bridge was built in 1978, as shown the structure in Figure 1 and the Figure 2 show the side view of the bridge structure. Sg. Perak Reservoir Bridge have 14 spans and 21 piers across the Banding Lake, between Army Camp of Gerik and the island of Banding, accommodating two vehicle lanes and a non-pedestrian walkway. It is a symmetrical suspension bridge having a total length of 880.52 meter over fourteen spans where the maximum span is 91.46 meter, and the width of the carriageway is 8.48 meter. It has a non-Reinforced Concrete (RC) tower but the overall conditions of the bridge is shown in Table 1 below.

These bridge structures serve as vital

components of transportation infrastructure. With the help of the Global Navigation Satellite System (GNSS), accurate measurements are obtained for a total of 21 piers, making up 22 single points on the bridge. These points have precise coordinates and orthometric height, allowing for detailed analysis and monitoring of the bridge's structural integrity. In order to capture a comprehensive understanding of the bridge's performance, vibration readings are recorded simultaneously during fast static GNSS observations. This comprehensive approach ensures that all aspects of the bridge's condition, including its interaction with the surrounding environment, are thoroughly assessed. By establishing these points on both the bridge shoulders and piers, a comprehensive understanding of the bridge's performance can be obtained, enabling informed decision-making and targeted maintenance strategies. The combination of GNSS technology and vibration readings provides valuable insights into the bridge's structural health and helps ensure the safety and longevity of these critical infrastructure assets.



Figure 1: The structure of Sungai Perak Reservoir Bridge
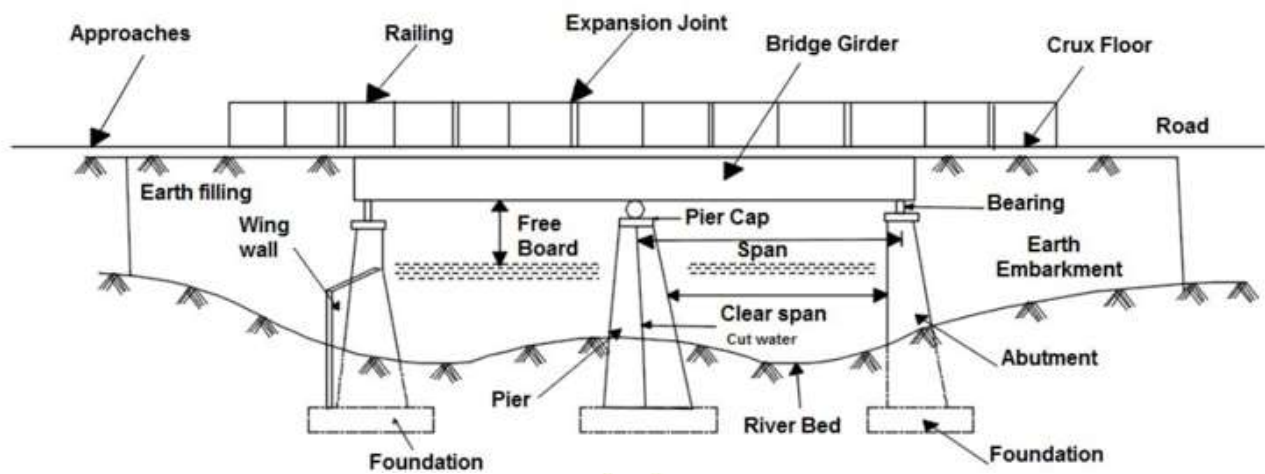


Figure 2: The side view of bridge structure

Table 1: Conditions of the Banding Bridge.

| Bridge Parts | Material / Type |
|---|---|
| Foundation | Piled (Bored Piles) |
| Abutment | Reinforces Concrete Bank seat |
| Pier | Reinforces Concrete Column |
| Bearing | Rubber Pad |
| Beam / Girder | Prestressed Concrete Beam |
| Deck / Crux Floor | Reinforces Concrete Slab |
| Surfacing | Bituminous |
| Expansion Joint | Acme 5502 Neoprene Tranflex - Movable |
| Parapet / Railing | Steel Post & Railing |
| Approach Slab | None |
| Slop / Scour Protection | Rock Protection |

## INTERGRETED METHOD WITH DASHBOARD APPROACH - DATA COLLECTION

According to Loos et al., (2016), data visualization displays are currently widely used in various fields with various designs due to their realistic and easy-to-use usage and availability. Data exploration and analysis in the form of information visualization and visual data analysis often help deal with large amounts of information. The advantage of visual data exploration is that the user does the most important part of being directly involved in the data entry and data interpretation process.

## INTERGRETED METHOD WITH DASHBOARD APPROACH – DESCRIPTION OF DATA

The efficiently display the dashboard generated by the methodology presented in this paper, where several dashboard description items are introduced. These items help describe files that contain information about graphical visualizations, bridge structure datasets, and bridge structure fixed information. In order to present a clear and concise overview of important or relevant information, visual representations and graphical embellishments are used to simplify and abstract numerous related data points. This time-efficient approach allows viewers to easily grasp the main points

Bach et al., (2023).

Figure 3 below shows the dashboard design methodology oriented to bridge structure inspection key-in data rules. An overview of the methodology of entering bridge inspection data through the Bridge Inspection system process, the first step is Add a Bridge to specify the name of the bridge and all the information on the bridge. If there is more than one bridge, the list of the bridges whose information entered will be listed. The next step is the inspection data key-in box being created which has been implemented by the PWD bridge inspection officer.

Each data information is according to the structural parameters of the bridge according to the level of damage based on the rating card. These is mandatory because this data will be able to be analyzed through the dashboard used. According to Kintz, (2012) in modelling process, they want to observe using system notation is a method that involves system users being monitored to determine goals and KPIs. In the process model, possible control points for further process control are also shown information, including goals and KPIs of interest to the user (i.e. the form display concept) are described and saved in a pdf format file.
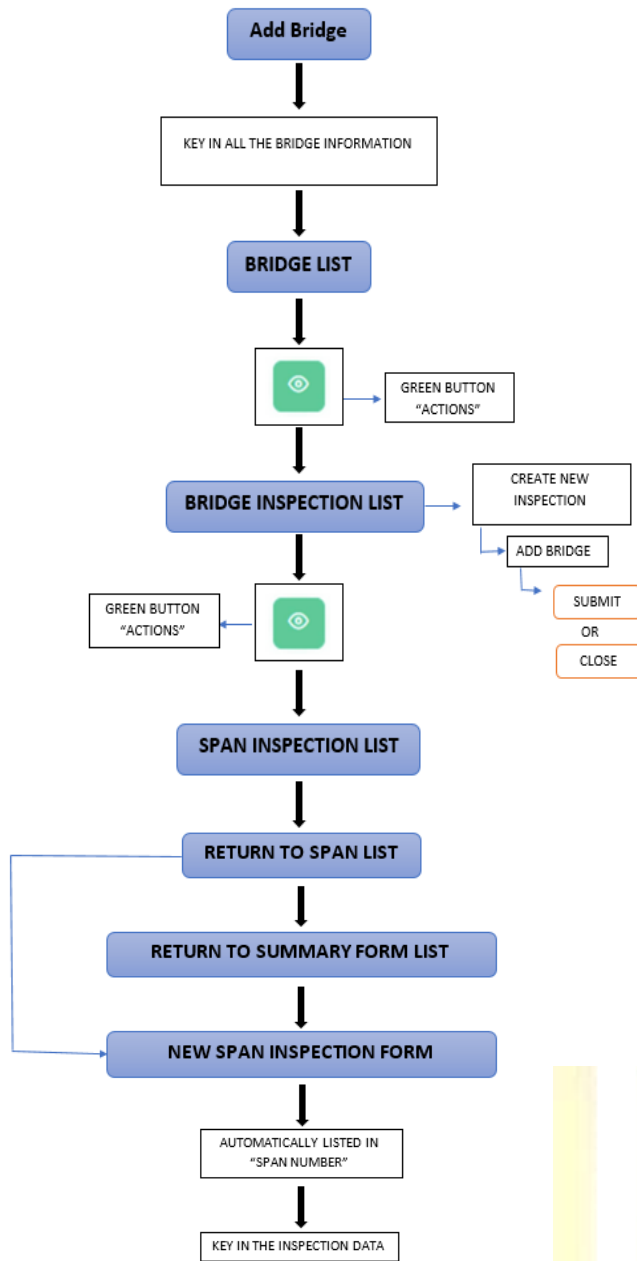
**Figure 3** Overview of the process key in inspection methodology.

Since these description operations can be complex, they are performed by experts, using user input. Based on this Pdf file, the entire monitoring infrastructure is then prepared automatically, and the coding to be integrated into the process engine that is running to send data to graphic form and then to the data warehouse for archiving is generated, to be integrated into the system. Once this infrastructure is in place, the dashboard generation phase can begin.

| Data type | Visualization |
|---|---|
| Bridge Summary Rating Over Year | Bar chart |
| Span Inspection Rating | Bar chart |
| Location of the Pier | Google Map |
| Summary Condition Inspection | Pdf Form |

Figure 4: Mapping data type to visualization

Match the data type with the visualization of Figure 4, answer common questions and follow the process like that defined and use best practices for chart selection and styling described in the information visualization literatura. According to Orlovskyi & Kopp, (2021), bar charts, line charts, and pie charts are the most effective for data visualization and human perception. Text cards can be used to display single-value measures like general measures, ratios, or scalar values. The main challenge in developing BI dashboards is selecting the right graphs and charts for visualization. To analyze datasets from SQL queries and recommend visualizations, we propose the following function:

$$\text{Visualization (DS)} = \begin{cases} |DS| = 1, & Card \\ 2 \leq |DS| \leq t_1, & Pie \\ t_1 + 1 \leq |DS| \leq t_2, & Bar \\ |DS| = t_2, & Line \end{cases}$$

In order to create a dashboard with a specific graph or chart, the dataset DS, which is obtained from an SQL query, needs to be analyzed. The upper threshold t1 represents the dataset size suitable for a pie chart visualization, while t2 represents the dataset size suitable for a bar chart visualization.

The literature on Vázquez-Ingelmo et al., (2020) has highlighted several Things like choosing visual forms to represent objects, designing basic computational/analytical algorithms, and even choosing interactions to attach visual representation with basic analytics are visualization capabilities. Therefore, data visualization is very useful for people to

know the data graphically because it can process, analyze and visualize a large amount of complicated data Khan, (2021).

## INSPECTION DECISIÓN

Design a dashboard to include bridge inspection data and show the findings in the form of a bar chart as follows. Each display needs to include information related to the bridge that is subject to this periodic inspection. As tated, the data entered is inspection data on each pier for all slabs. The value entered refers to the rating card where this value gives meaning to whether it is still good and safe or otherwise. Each data value entered will be accompanied by the reading of coordinates, height and also the maximum value of vibration at those points. This dashboard allows PWD bridge inspectors to store the inspector's data well and for a long time because these data will be analyzed from year to year.

## MAIN RESULTS

The discussed portions of the dashboard design methodologies and the acquisition data process monitoring technique have already been test run successfully implemented in practice. As a result, the Public Works Department's management application now incorporates a dashboard

specifically designed for the monitoring of bridge inspections. This dashboard empowers the inspection officer to conveniently enter data and customize their dashboards directly from a web browser. To provide a visual representation of the inspection bridge dashboard, please refer to Figures 4, 5, 6, and 7. These illustration of an inspection bridge dashboard. The integration of these advanced dashboard features has significantly enhanced the effectiveness and efficiency of the inspection process, aligning with the professional standards expected in the field.

Figure 5 shows the meticulously designed and organized bridge list. This comprehensive list, carefully curated by the bridge inspection officer, serves as a vital reference tool for the efficient management and maintenance of bridges. It is an essential component of the bridge folder, where each bridge is categorized and documented according to its name and unique specifications. With utmost professionalism, the bridge inspection officer enters all pertinent information into this bridge list, ensuring that it is readily accessible and easily navigable for future reference. This bridge list serves as a testament to the dedication and expertise required to ensure the safety and longevity of our bridge infrastructure.
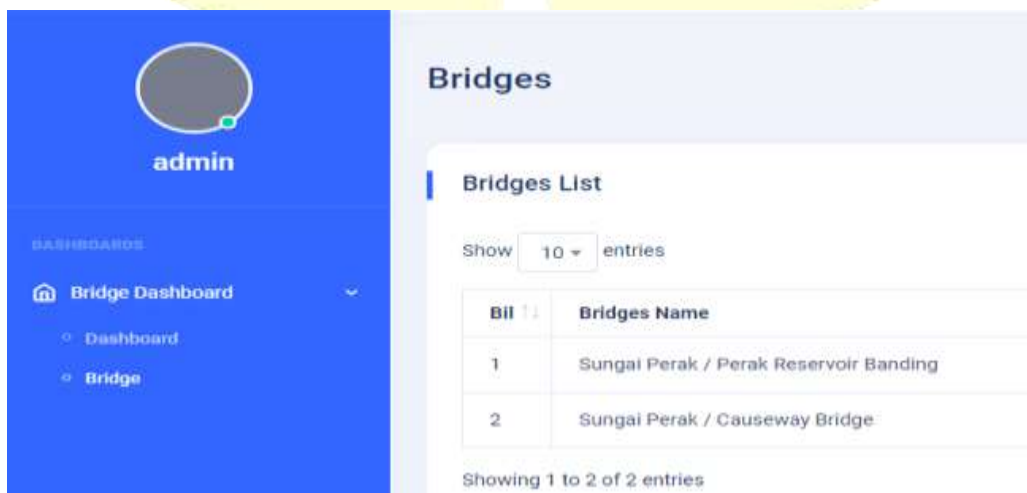


**Figure 5** The list of the inspection bridge in the Dashboard

The bridge inspection list, as depicted in Figure 6, serves as a valuable tool for inspection officers to document and input data obtained during physical inspections. By referencing the rating card values ranging from 1 to 4, officers can accurately assess the condition of various components comprising the pier structure. It is worth noting that this comprehensive bridge inspection list encompasses all parts of the pier structure, ensuring a thorough evaluation of the entire bridge. Additionally, the list is organized by year, providing a systematic approach to storing and managing the pier structure data for each inspection. This meticulous documentation allows for easy reference and analysis of the bridge's condition over time. By adhering to this standardized bridge inspection list, inspection officers can maintain a professional and consistent approach to bridge inspections, ultimately facilitating effective maintenance and ensuring the safety and longevity of these vital structures.



**Figure 6** The bridge inspection list interface in the Dashboard

Figure 7 provides a comprehensive view of the bridge inspection list interface, presenting it in a visually appealing bar chart format. This graphical representation allows for easy comprehension and analysis of the data. Additionally, the bridge location is accurately depicted on the Google Map, providing a geospatial context to the inspection list. This combination of the bar chart and Google Map integration ensures a professional and efficient approach to bridge inspections.
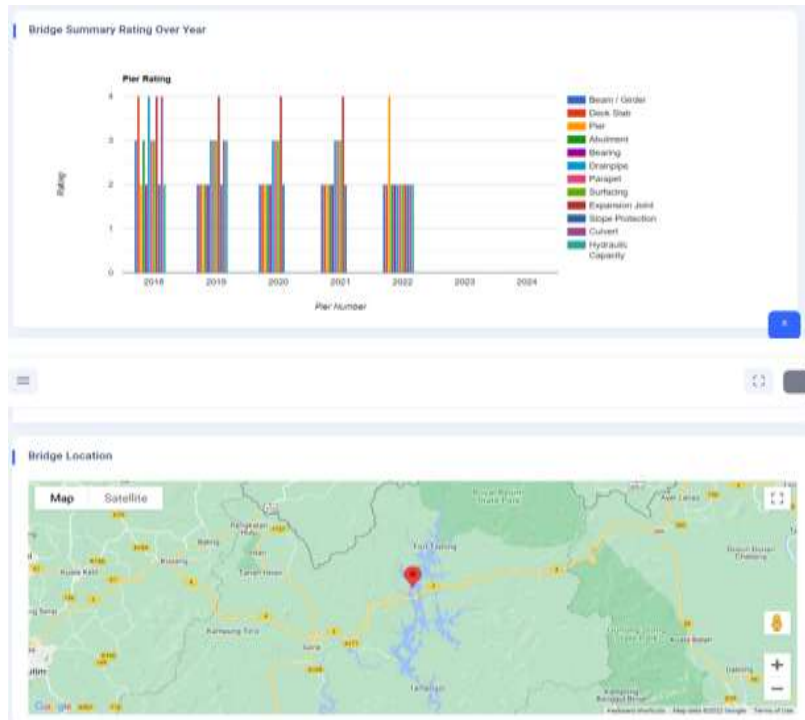
**Figure 7** The bridge inspection list interface in Bar chart and the bridge location in the Google Map.

Figure 8 showcases the routine condition inspection form that has been meticulously generated for easy perusal. This comprehensive document is designed to facilitate the systematic assessment and examination of various factors pertaining to the condition of a particular object or area. Its purpose is to ensure that all necessary aspects are thoroughly evaluated, allowing professionals to accurately determine the overall state and identify any potential issues or areas requiring attention. The routine condition inspection form serves as a vital tool, enabling professionals to maintain a high standard of quality and efficiency in their work.



**Figure 8** The routine condition inspection form have beign generate for the perusal.

## CONCLUSION

The concrete bridge inspection process with a data dashboard provides several advantages. It enhances data management, facilitates data-driven decision-making, improves communication among stakeholders, enables proactive maintenance planning, and promotes a safer and more efficient bridge infrastructure. By visualizing inspection data and key metrics in a clear and accessible manner, the data dashboard empowers engineers and decision-makers to identify potential issues early on, allocate resources effectively, and prioritize maintenance and repair activities to ensure the longevity and safety of bridges. Ultimately, this approach contributes to the overall improvement of transportation infrastructure and public safety.

Dashboard systems have revolutionized concrete bridge inspections by streamlining the inspection process, improving data analysis, and facilitating informed decision-making. By centralizing inspection data, providing visual representations, and promoting collaboration, these systems enhance the efficiency and effectiveness of bridge inspection and maintenance programs. Embracing dashboard systems in concrete bridge inspection systems is a significant step toward ensuring the safety and longevity of our critical infrastructure.

Selecting the right visualization is crucial, which is why we have introduced a function that maps a portion of data to a visual format and aids in providing recommendations for dashboard design. The provided example illustrates a sample dataset, a subset of the retrieved records, and a suggested visual chart for presentation on the dashboard. Further exploration in this field involves implementing the proposed approach in software and conducting research on the optimal size and placement of visualization graphs and charts within the dashboard area.

## ACKNOWLEDGEMENT

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# ASSESSING THE ACCURACY OF UNMANNED AERIAL VEHICLES FOR CONCRETE SLAB DEFLECTION MONITORING

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## ABSTRACT

The increased accessibility and affordability of unmanned aerial vehicles (UAVs) have led to their rapid adoption in the construction industry. This research aims to assess the accuracy and efficiency of UAV image processing for monitoring concrete slab deflection and compare it with conventional methods. Additionally, the study addresses the growing need for advanced and reliable technologies in the construction industry to enhance structural monitoring and ensure the safety and integrity of critical infrastructure. The study object focuses on a concrete slab (9m length and 9m width) at the Penang Waterfront Convention Centre (PWCC) building construction site in Penang. Aerial close-range photogrammetry was employed for the data collection using the DJI Mavic 2 Pro drone, with and without post-processing kinematics (PPK) modules. Analysis was conducted using software tools such as Agisoft Metashape, Global Mapper, and Cloud Compare. Flight planning was facilitated by DJI Pilot PE software, while ground control points (GCPs) were strategically positioned at the corners of the slab. Reference points were marked on the slab for data comparison with a total station and level instrument measurements. The study yielded varying levels of accuracy, with UAVs equipped with PPK modules and GCPs, achieving horizontal root mean square error (RMSE) values ranging from 1-3mm and vertical RMSE values between 2-3mm. UAVs without PPK modules and with GCPs, exhibited slightly higher RMSE values, with horizontal RMSE ranging from 4-5mm and vertical RMSE ranging from 5-6mm. UAVs without PPK modules and without GCPs demonstrated the highest RMSE values, with horizontal RMSE between 10-30mm and vertical RMSE between 10-40mm. These findings provide valuable insights into the accuracy and efficiency of UAVs in monitoring concrete slab deflection, emphasizing the importance of using PPK modules and GCPs references to achieve higher accuracy in image processing. Moreover, the study highlights the potential advantages of UAVs over conventional methods in terms of time, quality, manpower, and safety considerations, demonstrating their potential for enhancing construction monitoring practices.

*Keywords : Unmanned Aerial Vehicles (UAVs), DJI Mavic 2 Pro, Concrete Slab Deflection Monitoring, UAVs Post-Processing Kinematics (PPK), Point Clouds.*

## INTRODUCTION

Unmanned Aerial Vehicles (UAVs), commonly known as drones, have gained significant attention in the construction industry as a transformative tool for monitoring concrete slab deflection (Hada et al., 2020; Liu et al., 2018). The accessibility and affordability of UAVs have led to their widespread adoption, offering promising advantages over conventional methods (Hussein et al., 2019; Teizer et al., 2017). These aerial platforms provide a more efficient, cost-effective, and accurate approach to structural health assessment, addressing the limitations of labor-intensive and time-consuming manual measurements using laser levels or total stations (Choi et al., 2016; Huang et al., 2019).

Previous research has demonstrated the potential of UAVs in construction applications, particularly in the context of monitoring concrete slab deflection (Alba et al., 2021; Wu et al., 2020). Studies have successfully employed UAVs to monitor the deformation of concrete structures, showcasing their accurate measurement capabilities and contribution to structural health monitoring (Huang et al., 2017; Liu et al., 2019). Despite these promising results, a comprehensive analysis focused solely on UAVs for concrete slab deflection monitoring is still required (Baculi et al., 2020; Yang et al., 2018).

In the construction industry, the integration of UAV technology is experiencing a profound impact, as underscored by Smith et al. (2019) who describe it as a 'quantum leap' in efficiency and accuracy. UAVs enable real-time monitoring, facilitating quick decision-making critical for project timelines (Johnson, 2020). Moreover, they enhance safety by providing remote access to high-risk areas, reducing worker exposure (Brown & Chen, 2018). UAVs are pivotal in ensuring the structural integrity of projects, thanks to their unparalleled data quality (Garcia & Kim, 2017). Li and Wang (2020) emphasize that UAVs have shifted from being a trend to a necessity for modern construction, providing companies with a competitive edge.

The goal of this research is to provide crucial insights into the accuracy and efficiency of UAVs in monitoring concrete slab deflection, highlighting their potential advantages over conventional methods in terms of time, quality, manpower, and safety considerations (Hada et al., 2020; Liu et al., 2018). By quantifying the accuracy levels achieved by different UAV configurations, this study seeks to contribute to the existing literature on UAV applications in the construction industry (Teizer et al., 2017). The findings may support the wider adoption of UAV technology, ultimately enhancing construction monitoring practices and ensuring the structural integrity and safety of modern buildings.

In this research, we aim to assess the accuracy and efficiency of UAVs in monitoring concrete slab deflection. To underscore the significance of our study, we will compare our results with those of previous studies in the field. This comparative analysis will provide insights into how the accuracy of UAV-based monitoring has evolved and improved over time, emphasizing the novelty of our work.

## LITERATURE

### Photogrammetry

Photogrammetry is a sophisticated technique that utilizes photographs to create precise measurements and 3D representations of physical objects and environments (Wolf et al., 2004). It combines art, science, and technology, interpreting photographic images and radiant electromagnetic patterns to extract reliable information about the physical world. Capturing images from various angles and employing specialized software to process these images helps generate accurate 3D models.

One notable advantage of photogrammetry is its cost-effectiveness and efficiency compared to other 3D data

collection methods (Birch, 2006). It proves to be more affordable and less labor-intensive, producing high-quality data with unmatched detail, accuracy, range, and price. Research by Sagiroglu (2004) shows that photogrammetric methods are significantly faster and more graphically accurate than conventional methods, with a remarkable increase in precision.

The applications of photogrammetry are diverse, spanning engineering, architecture, and surveying (Matthews, 2008). It is widely used in creating precise 3D models of buildings, landscapes, and various physical objects. The technique also facilitates distance, area, and volume measurements, making it a valuable tool in engineering and construction projects. Additionally, photogrammetry's ability to generate accurate maps and models of archaeological sites and historical structures contributes crucial information for preservation and restoration endeavors (Wolf et al., 2004).

## UAV System

Unmanned Aerial Vehicles (UAVs) have revolutionized photogrammetry surveys with high-resolution imagery and cost-effectiveness. Fixed-wing UAVs excel in large-scale mapping due to extended flight endurance (Jahanbakhshi et al., 2018). Rotary-wing UAVs offer agility and capture detailed imagery at lower altitudes (Cai et al., 2018). Hybrid UAVs combining both capabilities enhance suitability for varied topography (Zhou et al., 2020). Figure 1 shows the Classification of UAVs based on wings and rotors.



**Figure 1** Classification of UAV based on wings and rotors.

UAVs use cameras, LiDAR, and hyperspectral sensors in photogrammetry surveys. Cameras provide affordable and high-quality imagery for precise 3D models (Shahbazi et al., 2019). LiDAR excels in mapping complex terrains with accuracy and efficiency (Wang et al., 2019). Hyperspectral sensors enable UAVs to gather valuable data for agriculture and environmental monitoring applications (Faccio et al., 2018).

UAVs and their sensor technologies transform surveying with efficient and versatile mapping solutions at reduced costs. UAV impact is supported by cited references (Jahanbakhshi et al., 2018; Cai et al., 2018; Zhou et al., 2020; Shahbazi et al., 2019; Wang et al., 2019; Faccio et al., 2018).

## Post-Processing Kinematics (PPK) Modules for UAV Drones

Unmanned Aerial Vehicles (UAVs), or drones, have transformed industries with their cost-effective data acquisition. Ensuring accurate geospatial data has been a challenge. Post-Processed Kinematic (PPK) modules offer a solution. These specialized GPS receivers capture raw satellite data during UAV flights and achieve centimeter-level accuracy in georeferenced data after post-processing with nearby base station information (Johnson et al., 2022).

The PPK requires two constant communication lines to correct satellite location data: 1. The line between satellites and GNSS base station or CORS network, and 2. the line between satellites and drone. The illustrations of the Post-Processing Kinematic (PPK) Module are shown in Figure 2.
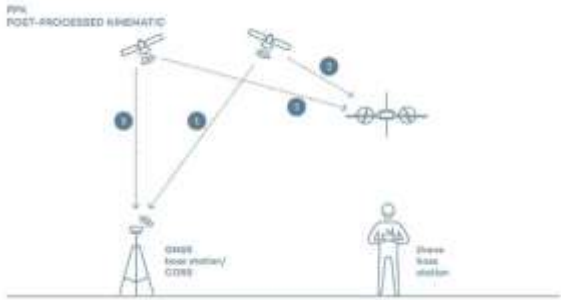
**Figure 2** Illustrations of the Post-Processing Kinematic (PPK) Module

PPK integration has advantages: enhanced surveying accuracy compared to ground-based methods, georeferencing without real-time corrections, covering larger areas in one flight, and expanding applications to remote or challenging regions (Lee et al., 2023; Anderson et al., 2023; Zhang et al., 2021). Challenges include data processing time and the need for GNSS base station access (Brown et al., 2022; Zhang et al., 2021).

Advancements in PPK technology include onboard processing, reduced post-processing time, and support for multiple GNSS constellations, like GPS, GLONASS, Galileo, and BeiDou (Brown et al., 2022; Lee et al., 2023).

In conclusion, PPK-enabled UAVs revolutionize aerial surveying and mapping with high accuracy and efficiency across various industries (Anderson et al., 2023).

**Ground Control Point (GCP)**

Ground Control Point (GCP) is an essential component in UAV aerial photogrammetry for surveying engineering. GCPs are used as a reference point to determine the accuracy of the generated 3D model and to improve the overall quality of the surveying results. According to Sun et al. (2019), GCPs are necessary to validate the accuracy of the UAV surveying data, especially for large scale mapping projects. The placement of GCPs is critical and requires careful consideration of the terrain and the project objectives.

In recent years, there has been a growing interest in the use of drones for surveying and mapping applications due to their cost-effectiveness and efficiency (Li et al., 2017). However, the accuracy of the generated surveying results heavily relies on the quality and number of GCPs used in the project. Several studies have shown that the use of a higher number of GCPs can improve the accuracy of the surveying results (Habib et al., 2017). Additionally, the distribution of GCPs must be carefully considered to ensure that they cover the entire surveying area. Figure 3 shows the illustrated connection between Photogrammetry image acquisition and the GCPs tie points.
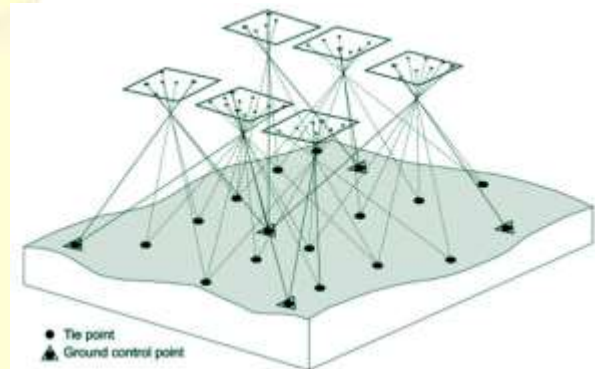


**Figure 3** Illustrate the connection between Photogrammetry image acquisition and the Ground Control Points (GCPs) tie points

The use of GCPs in UAV aerial photogrammetry has been shown to be beneficial in various applications. For instance, GCPs have been used to improve the accuracy of digital elevation models (DEM) and digital surface models (DSM) (Kacimi et al., 2020). The use of GCPs has also been shown to be critical in generating accurate orthomosaics, which are commonly used in agriculture and land use planning (Zhang et al., 2018).

In conclusion, the use of Ground Control Points (GCPs) in UAV aerial photogrammetry is critical to improving the accuracy of surveying results. The placement and distribution of GCPs must be carefully considered to ensure the generation of accurate 3D models, DEMs, and DSMs. A higher number of GCPs can improve the accuracy of surveying results,

which has been shown to be beneficial in various applications such as land use planning and agriculture.

## Application of UAVs in Construction

Unmanned Aerial Vehicles (UAVs) or drones have revolutionized the construction industry by enhancing safety, data collection, and cost savings. They are extensively used for site surveying, capturing detailed data, and generating 3D models, enabling better project planning (Zhang et al., 2020). Some of the application fields of UAV as remote measurement systems are shown in Figure 4.
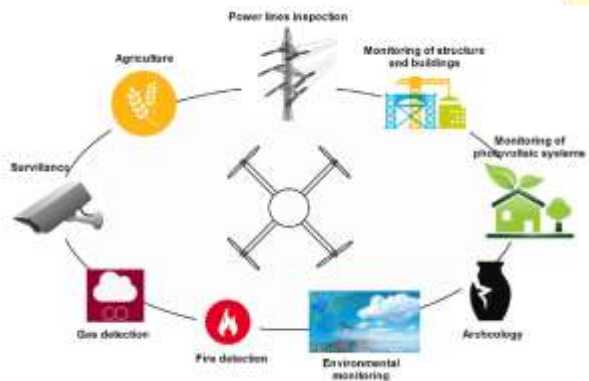


**Figure 4** Application fields of UAV as remote measurements systems

## RESEARCH METHODOLOGY

### Data Acquisition

An area is being surveyed at the construction site of the Penang Waterfront Convention Centre (PWCC) in Penang, Malaysia. The study focuses on a concrete slab with dimensions of 9 meters in length and 9 meters in width. The area location as shown in Figure 5a, and 5b. The data was acquired on June 23, 2022

UAVs have a crucial role in construction monitoring. Equipped with real-time imaging, they remotely track progress, providing up-to-date information to streamline project management and meet timelines (Teizer et al., 2018).
However, challenges concerning data accuracy, technology selection, initial costs, and regulatory compliance need to be addressed. Ensuring precise data collection through best practices is essential (König et al., 2017). Selecting the most suitable UAV platform, considering flight range, payload capacity, and sensor capabilities, is vital (Boschetti et al., 2019). While the initial investment may be significant, the long-term ROI justifies the adoption of UAVs in construction (Domingo-Perez et al., 2021). Navigating airspace regulations, privacy concerns, and data protection laws is crucial (Zhang et al., 2018).

In conclusion, UAVs have transformed construction with benefits in surveying, monitoring, and project management. Addressing challenges and staying abreast of technological advancements will further enhance their role in shaping the industry's future.



**Figure 5a** Overview of the study area

**Figure 5b** Concrete slab monitoring area

### Dji Mavic 2 Pro

For our field test, the DJI Mavic 2 Pro is a highly portable consumer-grade UAV with a foldable design. It features a Hasselblad L1D-20c camera equipped with a 1-inch CMOS sensor, offering a 20-megapixel resolution and an adjustable aperture from f/2.8 to f/11. With 3-axis gimbal stabilization, the drone ensures smooth 4K video recording at up to 30fps and Full HD video at up to 120fps. Intelligent flight modes like ActiveTrack 2.0, Hyperlapse, and QuickShots enhance its usability, while the obstacle sensing system improves flight safety. The Mavic 2 Pro's flight capabilities include a maximum flight time of 31 minutes, allowing for extended aerial exploration and data collection. It is controlled through the DJI GO 4 or DJI Fly app using a dedicated remote controller with OcuSync 2.0 technology for a stable connection.

One standout feature for professional applications is the drone's GPS system, highly useful for photogrammetry. It provides precise geolocation data for each captured image, aiding in the generation of accurate 3D models. The GPS enables proper ground control point placement, flight planning, and georeferencing of the final model. Its reliability ensures scale and measurement accuracy, assists in time-stamping images, and enhances project documentation and reporting. The Mavic 2 Pro's GPS system is equipped with a dual-frequency receiver, combining GPS and GLONASS signals for enhanced accuracy, with a specified horizontal accuracy of ±1.5 meters and a vertical accuracy of ±0.5 meters. This reliable GPS positioning ensures stable flight, precise navigation, and accurate geolocation for aerial applications like surveying, mapping, and environmental monitoring.

### Mavic 2 Pro with PPK Module

As part of my research, I utilize the GAMA PPK module, specifically designed for the DJI Mavic 2 Pro drone, to enhance geolocation accuracy and orthophoto production. The GAMA PPK module is an accessory that attaches to the Mavic 2 Pro and works in conjunction with its GPS receiver. During the flight, the module records raw GNSS data, and post-flight, this data is post-processed along with ground-based reference station data to calculate precise drone positions and orientations. Figure 6 displays a photo of the DJI Mavic 2 Pro UAV with the PPK Module. Figure 7 shows the components of the PPK Module designed for the Mavic 2 Pro, while Table 1 presents the product specifications of the PPK Module.



**Figure 6** Photo of the DJI Mavic 2 Pro UAV with the PPK Module
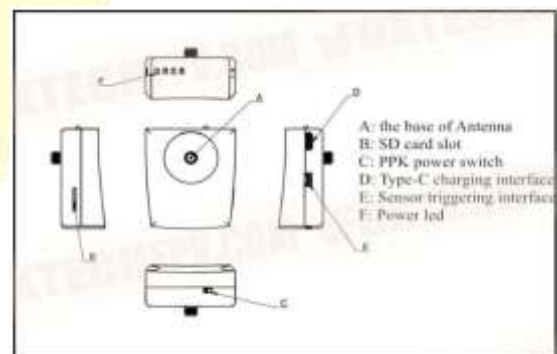


**Figure 7** Component of PPK Module for Mavic 2 Pro

**Table 1** Product specifications of the PPK Module

| Part specification | Value |
|---|---|
| Weight | 56g |
| Charging timer (Max) | 2 hours |
| Max Battery LIfe | More than 12 hrs |
| GNSS signal | GpPS/QZSS L1 GLONASS G1 BeiDou B1 Galilwo E1 SBAS |
| Numbers of Channels | 72 |
| Rate | 5Hz   10Hz |
| Storage | 16GB |
| Data logging | Renix |
| Led | Power, Logging, Sat, Event |

**Flight Planning**

The flight planning is performed using DJI Pilot PE for drone flight planning, setting the flying altitude at 15 meters and the speed at 1.1 meters per second. Each image is captured with a 70% overlap both horizontally and vertically, ensuring comprehensive coverage, while the ground sample distance is calculated at 0.47 centimeters to achieve high-resolution images. To optimize processing time, the flight is conducted in a single grid mode with four strips, following the acquisition flight plan shown in Figure 8. In total, 35 images are captured, showcasing the best coverage, and these images are subsequently processed using the Agisoft Metashape software to obtain the desired results.



**Figure 8** UAV flight plan over the study

area with image capture locations

**Ground Control Point and Monitoring Points**

For the purpose of this study, a total of 5 Ground Control Points (GCPs) are strategically employed. One GCP is established using the same nail marker that is utilized on the concrete slab. The remaining 4 GCPs are marked with targets affixed to the concrete slab as shown in Figure 9. The precise coordinates of each GCP are determined using a Total Station instrument, ensuring accurate location data.



**Figure 9** Location of 5 Ground Control Points (GCPs) and 25 monitoring points placed at the Slab Monitoring Area

For comparison purposes, 25 monitoring points are marked on the concrete slab as shown in Figure 6. Data surveys are conducted using both the Total Station and leveling instrument to collect relevant information at these monitoring points as shown in Figure 10a and Figure 10b.

**Figure 10a** Data acquisition for the X, Y coordinate locations in the study area is conducted using a Total Station for monitoring purposes



**Figure 10b** Data acquisition for the points height level of points in the study area is conducted using a levelling instrument for monitoring purposes

**Data acquisition by using DJI Mavic 2 Pro with PPK Module**

In the data acquisition methodology, the initial phase entails the establishment of a GNSS instrument base station within the designated study area to procure Rinex data. This dataset serves as a reliable reference for obtaining precise coordinates during the subsequent post-processing stage. Following this, an unmanned aerial vehicle (UAV) drone, specifically the DJI Mavic 2 Pro equipped with a Post-Processed Kinematic (PPK) Module, is deployed over the study area to conduct aerial imagery capture. The PPK

Module accurately records GPS data at predetermined intervals, effectively synchronizing it with the acquired images.

Upon completing the flight, the image data, along with the Rinex data from the base station GNSS instrument, is downloaded for further processing. Georeferencing correction of the images is carried out using the Emlid Studio software, utilizing the Rinex data to enhance the accuracy of GPS coordinates associated with each image.

The subsequent step involves using Agisoft Metashape, a powerful photogrammetry software, for image processing. The three-step method includes processing geotagged images along with Ground Control Points (GCPs) to generate highly accurate and georeferenced outputs. GCPs serve as additional reference points, ensuring the accuracy of the final data products.

In the second step, raw images are processed along with GCPs to further refine the georeferencing, utilizing known ground control coordinates.

Finally, the third step focuses on processing the images without using any GCPs, allowing an assessment of the accuracy and quality of the georeferenced data solely based on the PPK Module for positioning. The flowchart of image processing gathered from a UAV with a PPK module is shown in Flowchart 1.



**Flowchart 1** Flowchart of image processing from UAV PPK Module

By implementing this comprehensive approach, precise and reliable geospatial data is collected using the UAV drone equipped with the PPK Module. The integration of GNSS base station data and post-processing techniques with Emlid Studio and Agisoft Metashape provides accurate georeferenced data for the research, which is crucial for successful analysis and interpretation of the study area.

## RESULT AND DISCUSSION

This research aims to evaluate the accuracy and efficiency of UAV image processing for monitoring concrete slab deflection and compares it with conventional methods. Aerial close-range photogrammetry is performed using the DJI Mavic 2 Pro drone with different configurations, including UAVs with post-processing kinematics (PPK) modules and ground control points (GCPs), UAVs without PPK modules but with GCP references, and UAVs without both PPK modules and GCP references.

The results reveal varying levels of accuracy depending on the UAV setup. UAVs equipped with PPK modules and GCPs demonstrate the highest accuracy, with horizontal root mean square error (RMSE) values ranging from 1-3mm and vertical RMSE values between 2-4mm. Incorporating PPK modules significantly improves positional accuracy, reducing errors and enhancing data reliability. The complete extracted data for Horizontal and Vertical Root Mean Square Error (RMSE) is presented in Table 2 and Table 3, respectively. The data was obtained using UAVs equipped with PPK modules and GCPs were established.

**Table 2** Horizontal RMSE values by using PPK Module UAV and GCPs

| POINTS | DESIGN COORDINATE E | DESIGN COORDINATE N | POINT CLOUD COORDINATE E | POINT CLOUD COORDINATE N | DIFF E | DIFF N |
|---|---|---|---|---|---|---|
| 1 | -3141.127 | -5628.131 | -3141.126 | -5628.129 | -0.001 | -0.002 |
| 2 | -3139.155 | -5628.462 | -3139.153 | -5628.460 | -0.002 | -0.002 |
| 3 | -3137.182 | -5628.793 | -3137.181 | -5628.792 | -0.001 | -0.001 |
| 4 | -3135.210 | -5629.123 | -3135.209 | -5629.123 | -0.001 | 0.000 |
| 5 | -3133.237 | -5629.454 | -3133.234 | -5629.453 | -0.003 | -0.001 |
| 6 | -3133.613 | -5631.434 | -3133.611 | -5631.432 | -0.002 | -0.002 |
| 7 | -3135.540 | -5631.096 | -3135.539 | -5631.094 | -0.001 | -0.002 |
| 8 | -3137.513 | -5630.765 | -3137.512 | -5630.763 | -0.001 | -0.002 |
| 9 | -3139.485 | -5630.434 | -3139.483 | -5630.433 | -0.002 | -0.001 |
| 10 | -3141.458 | -5630.104 | -3141.456 | -5630.101 | -0.002 | -0.003 |
| 11 | -3141.789 | -5632.076 | -3141.787 | -5632.074 | -0.002 | -0.002 |
| 12 | -3139.816 | -5632.407 | -3139.813 | -5632.405 | -0.003 | -0.002 |
| 13 | -3137.844 | -5632.738 | -3137.843 | -5632.737 | -0.001 | -0.001 |
| 14 | -3135.871 | -5633.068 | -3135.869 | -5633.066 | -0.002 | -0.002 |
| 15 | -3133.899 | -5633.399 | -3133.896 | -5633.397 | -0.003 | -0.002 |
| 16 | -3134.229 | -5635.372 | -3134.225 | -5635.370 | -0.004 | -0.002 |
| 17 | -3136.202 | -5635.041 | -3136.200 | -5635.040 | -0.002 | -0.001 |
| 18 | -3138.174 | -5634.710 | -3138.172 | -5634.707 | -0.002 | -0.003 |
| 19 | -3140.147 | -5634.379 | -3140.144 | -5634.374 | -0.003 | -0.005 |
| 20 | -3142.119 | -5634.049 | -3142.117 | -5634.047 | -0.002 | -0.002 |
| 21 | -3142.450 | -5636.021 | -3142.449 | -5636.017 | -0.001 | -0.004 |
| 22 | -3140.478 | -5636.352 | -3140.477 | -5636.350 | -0.001 | -0.002 |
| 23 | -3138.505 | -5636.683 | -3138.503 | -5636.680 | -0.002 | -0.003 |
| 24 | -3136.533 | -5637.013 | -3136.530 | -5637.008 | -0.003 | -0.005 |
| 25 | -3134.560 | -5637.344 | -3134.558 | -5637.343 | -0.002 | -0.001 |
| Horizontal Root Mean Square Error (RMSE) (m) | | | | | 0.001 | 0.002 |

**Table 3** Vertical RMSE values by using PPK Module UAV and GCPs

| POINTS | SLAB LEVEL(m) | FROM CLOUDCOMPARE (m) | DIFFERENT(mm) |
|---|---|---|---|
| 1 | 11.442 | 11.443 | -0.001 |
| 2 | 11.445 | 11.442 | 0.003 |
| 3 | 11.443 | 11.447 | -0.004 |
| 4 | 11.444 | 11.440 | 0.004 |
| 5 | 11.440 | 11.436 | 0.004 |
| 6 | 11.446 | 11.450 | -0.004 |
| 7 | 11.445 | 11.449 | -0.004 |
| 8 | 11.439 | 11.440 | -0.001 |
| 9 | 11.446 | 11.449 | -0.003 |
| 10 | 11.446 | 11.448 | -0.002 |
| 11 | 11.444 | 11.448 | -0.004 |
| 12 | 11.439 | 11.443 | -0.004 |
| (GCPS) 13 | 11.429 | 11.428 | 0.001 |
| 14 | 11.429 | 11.425 | 0.004 |
| 15 | 11.434 | 11.436 | -0.002 |
| 16 | 11.443 | 11.447 | -0.004 |
| 17 | 11.437 | 11.441 | -0.004 |
| 18 | 11.433 | 11.435 | -0.002 |
| 19 | 11.441 | 11.443 | -0.002 |
| 20 | 11.444 | 11.447 | -0.003 |
| 21 | 11.445 | 11.447 | -0.002 |
| 22 | 11.446 | 11.448 | -0.002 |
| 23 | 11.448 | 11.452 | -0.004 |
| 24 | 11.441 | 11.444 | -0.003 |
| 25 | 11.443 | 11.441 | 0.002 |
| GCP3 | 11.450 | 11.451 | -0.001 |
| GCP2 | 11.445 | 11.443 | 0.002 |
| GCP1 | 11.450 | 11.450 | 0.000 |
| GCP4 | 11.447 | 11.449 | -0.002 |
| Vertical Root Mean Square Error (RMSE) (m) | | | 0.001 |

In contrast, UAVs without PPK modules but with GCP references exhibit slightly higher RMSE values, with horizontal RMSE ranging from 4-5mm and vertical RMSE ranging from 5-6mm. Nevertheless, these results still provide reasonably precise measurements. Table 3 displayed the horizontal and vertical Root Mean Square Error (RMSE) values that were obtained using Ground Control Points (GCPs) and without the Post-Processed Kinematic (PPK) module in the UAV.

**Table 3** Horizontal and vertical RMSE values by using GCPs and without PPK Module UAV

| Horizontal RMSE with GCPs, without PPK Module UAV | | |
|---|---|---|
| Horizontal Root Mean Square Error (RMSE) (m) | 0.004 | 0.005 |

| Vertical RMSE with GCPs, without PPK Module UAV | | |
|---|---|---|
| Vertical Root Mean Square Error (RMSE) (m) | 0.006 | |

**Table 4** Horizontal and vertical RMSE values by without using GCPs and without PPK Module UAV

| Horizontal RMSE without GCPs, without PPK Module UAV | | |
|---|---|---|
| Horizontal Root Mean Square Error (RMSE) (m) | 0.027 | 0.029 |

| Vertical RMSE without GCPs, without PPK Module UAV | | |
|---|---|---|
| Vertical Root Mean Square Error (RMSE) (m) | 0.038 | |

UAVs without both PPK modules and GCP references demonstrate the least accuracy, with horizontal RMSE between 10-30mm and vertical RMSE between 10-40mm. This highlights the critical role played by PPK modules and GCPs in improving UAV image processing accuracy for concrete slab deflection monitoring. Table 4 presented the horizontal and vertical Root Mean Square Error (RMSE) values obtained without utilizing Ground Control Points (GCPs) and the Post-Processed Kinematic (PPK) module in the UAV.

Figure 11 displays the point cloud of the process image, which was analyzed using Cloud Compare software. The best-fit results are presented for the as-built concrete slab level, clearly revealing the slab deflection.
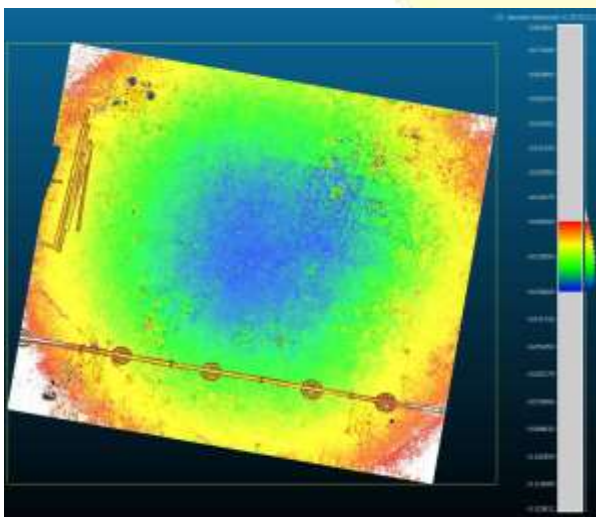


**Figure 11** As-built of the concrete slab level, process using the Cloud Compare software.

**Table 5** Comparison findings with previous research on concrete slab deflection monitoring using UAV

| Study | UAV Configuration | Accuracy Level (RMSE) - Vertical (mm) | Accuracy Level (RMSE) - Horizontal (mm) | Flight Height (m) | UAV Model | Ground Sample Distance (GSD) |
|---|---|---|---|---|---|---|
| Hada et al., 2020 | PPK + GCP | 2-4 | 1-3 | 15 | DJI Mavic 2 Pro | 0.47 cm |
| Alba et al., 2021 | GCP | 4-6 | 5-7 | 25 | SenseFly eBee | 0.2 cm |
| Wu et al., 2020 | PPK + GCP | 3-5 | 2-4 | 18 | DJI Matrice 300 | 0.45 cm |
| Huang et al., 2017 | PPK + GCP | 3-4 | 2-3 | 12 | DJI Phantom 4 | 0.4 cm |
| My Research Study | PPK + GCP | 2-3 | 1-3 | 15 | DJI Mavic 2 Pro | 0.47 cm |

In Table 5, we compared our research with four previous studies on concrete slab deflection monitoring. We included details on the UAV configuration, accuracy levels (RMSE) in both vertical and horizontal measurements, flight height, the model of UAV used, ground sample distance (GSD), and the key adjustment or image processing software used in each study. This comparison highlighted the evolution of accuracy levels achieved by different UAV configurations and emphasized the significance of our research in improving accuracy and efficiency in concrete slab deflection monitoring.

**Advantages of UAVs over Conventional Methods**

The study identifies several advantages of employing UAVs for construction monitoring compared to traditional methods, underscoring the pivotal role of this technology in enhancing the construction industry's efficiency, safety, and data quality. UAVs not only streamline data collection but also provide a safer means of monitoring construction progress, reducing risks to on-site personnel. Furthermore, the accurate and timely data they deliver empowers construction professionals to make well-

informed decisions, ultimately contributing to the successful and cost-effective execution of construction projects

## Increased Accuracy

UAVs with Post-Processed Kinematic (PPK) modules and Ground Control Points (GCPs) deliver precision measurements, achieving horizontal and vertical accuracy levels as low as 1-3mm. This precision eliminates human errors, ensuring consistent and correctly georeferenced data.

## Increased Efficiency

UAVs offer real-time monitoring, rapid data collection, and minimized resource allocation. They capture high-resolution images swiftly, reducing the need for manual measurements and labor. Digital data accessibility streamlines communication and decision-making among stakeholders.

## Beneficial Implications

The accuracy and efficiency gains translate into cost savings, improved safety, and better decision-making. Reduced errors mean fewer rework costs, and real-time monitoring prevents costly delays. UAVs enhance safety by eliminating human exposure to hazards, all while fostering higher-quality construction projects through precise data.

## Time Efficiency

UAVs significantly reduce data collection time compared to conventional methods. Rapidly capturing images while flying over the entire concrete slab allows for real-time monitoring and timely decision-making by project managers and engineers.

## Manpower Requirements

Unlike conventional methods that often demand a substantial workforce for data collection, UAVs require minimal human intervention. This decreases the need for manpower, allowing personnel to focus on other critical aspects of the construction project.

## Safety Considerations

Construction sites pose hazards for human workers. Utilizing UAVs enables construction companies to mitigate risks to workers' safety by monitoring structures from a safe distance, eliminating the need for personnel to access high or potentially dangerous areas.

## Data Quality

The study demonstrates that UAVs equipped with PPK modules and GCP references yield highly accurate data. This ensures reliable analysis, aiding engineers in making well-informed decisions regarding construction progress and potential corrective actions.

## Beneficial Implications

It's crucial to highlight how the findings of our research can benefit construction projects. We will expand on the implications of our study, explaining how the increased accuracy and efficiency offered by UAVs can lead to cost savings, improved safety, and better decision-making in construction monitoring.

## RECOMMENDATIONS AND FUTURE IMPLICATIONS

Based on the research findings, it is recommended that construction companies and engineers employ UAVs with PPK modules and GCP references for monitoring concrete slab deflection, as this configuration demonstrates the highest level of accuracy and provides reliable data for construction analysis and decision-making.

Future research should explore the applicability of UAVs in monitoring other construction elements beyond concrete slabs, such as structural beams, columns, and facades. Additionally, investigating the potential integration of artificial intelligence and machine learning

algorithms to automate data analysis could further enhance the efficiency and accuracy of UAV-based monitoring systems.

## CONCLUSION

In conclusion, this research not only assesses the accuracy of UAVs for concrete slab deflection monitoring but also places our findings in the context of previous studies, highlighting the advancements in this field. By emphasizing the potential benefits of our research to the construction industry and suggesting future research directions, we aim to contribute significantly to the adoption of UAV technology in construction monitoring. The continuous exploration and refinement of UAV technologies in construction are essential for enhancing project efficiency, safety, and decision-making processes.

This research underscores the significant potential of UAV-based monitoring in accurately assessing concrete slab deflection. Utilizing PPK modules and GCP references results in the highest level of accuracy, while the absence of these components leads to reduced precision. The importance of employing proper image processing techniques is emphasized. Furthermore, the study highlights the numerous advantages offered by UAVs over traditional methods, including improved time efficiency, enhanced data quality, reduced manpower requirements, and increased safety considerations. Careful consideration of equipment selection, flight planning, and personnel training is crucial to fully leverage the benefits of UAV-based monitoring. This research provides valuable insights for enhancing construction monitoring practices and underscores the need for continued exploration and refinement of UAV technologies in this field.

In summary, our study not only advances the accuracy of concrete slab deflection monitoring but also advocates for the wider adoption of UAV technology in construction, ultimately contributing to more efficient, safe, and data-driven construction practices in the industry.

## ACKNOWLEDGEMENT

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# SIMULATION AND MODELLING OF TREE ROOTS USING GPR AND NUMERICAL ANALYSIS

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## ABSTRACT

Traditional methods to check tree roots are complicated due to their destructive nature and limited quantitative assessments in long-term research. Therefore, this study aims to understand the synergistic use of the Ground Penetrating Radar (GPR) to obtain accurate information on tree root health. For this purpose, geophysical and surveying techniques are used. In the study, image data of tree roots were obtained using IDS Duo GPR under normal conditions. To obtain the most accurate results in GPRMax, the simulation used the greatest contrast dielectric value of soil and roots. Then, an analysis is conducted to compare synthetic and real data. Modelling is crucial to understand electromagnetic wave propagation and interaction with tree roots. First, the synthetic hyperbola's shape is compared with the real root's hyperbola. Second, roots with increasing diameters were simulated and the time interval associated with each diameter was determined to produce a regression line model. Finally, depending on the real-time interval and the collected data, the regression model is utilised to estimate the true diameter. The study found the following: (1) the results show that the high dielectric value of the detected roots, real and synthetic hyperbola, have similar amplitude and tail; (2) the findings demonstrate that the estimation model is good with an average error of ±8 mm under ideal conditions and ±20 mm under normal conditions. The estimation variation is strongly influenced by soil moisture. The GPR resolution and signal deteriorate when the high soil moisture content is high. As a result, this study could provide vital insight for more effective assessment of tree roots and serve as an important reference for researchers seeking to expand on present findings.

*Keywords : roots, diameter, GPR,GPRMax, simulation*

## INTRODUCTION

In recent years, tree roots detection has become increasingly important, especially in terms of economic growth, climate change, and environmental protection. Much research has been conducted on theory development related to tree roots detection such as limiting factors, estimating biomass by determining diameter, and more. Tree root systems are critical for providing information needed for environmental safety, underground utility mapping, biomass estimation, construction sites, building structures, and other applications (Cheng et al., 2014). However, interpreting tree roots from the

radargram is difficult due to the dielectric contrast between the soil and the root, root orientation (Liu et al., 2018), moisture content, and nearby substances (Zhu et al., 2014). Since it is difficult to interpret and estimate the size, position, and direction of the roots, a preliminary analysis must be performed to improve the interpretation and analysis of the roots. The GPRMax software was used to simulate the wave propagation based on the environmental model. It is an open source, software that is user friendly, and can be used to generate a large numbers of test data to improve the understanding of the tree root study (Giannopoulos, 2005; Warren et al., 2016).

Trees should be monitored over time, and the best technique at present is GPR because it is non-invasive, fast, reliable, inexpensive, and widely used to study tree roots (Guo et al., 2013; Hirano et al., 2012; Isaac & Anglaaere, 2013; Raz-Yaseef et al., 2013; Tanikawa et al., 2013). GPR has enable root system and plant exploration in a non-invasive way (Cui et al., 2011), including coarse root mapping (Hirano et al., 2009), reconstruction of root system architecture (Zhu et al., 2014), and estimation of root diameter or biomass (Cui et al., 2013). Root detection using GPR study now focuses on root depth, diameter, growth direction, water content, biomass, spreading area, and reconstruction of three-dimensional structure (Aboudourib et al., 2021). Much research has been done to improve tree root detection and analysis. Under one investigation, tree root of *C. Japonica* were examined in optimal sandy soil conditions using 900 MHz GPR (Fan et al., 2015; Keitaro et al., 2018). It was found that well-defined hyperbola was detected when water content was greater than 20%, depth was less than 80 cm, and intervals was greater than 20 cm, showing the important effects of root diameter, water content, and vertical and horizontal spacing on root detection accuracy (Hirano et al., 2009).

Successful detection refers to the precise assessment of the tree root position, size, direction, and health, which is important for accurate analysis and application. For example, detection of dead trees and roots can be used to measure disease and risk before trees are pruned or cut because they are harmful to people, utilities, and the environment. However, there is also a general guideline to use when deciding whether prune roots. For instance, roots larger than 2 inches should not be pruned. Removing large tree roots can make the tree unstable or unhealthy later on. The tree may not be able to receive enough nutrients and water. Tree roots can be safely cut if they do not exceed five times the diameter of the tree. However, soil constituents have a significant effect on the depth of penetration (Campos et al., 2019) and electrical conductivity of nearby materials (Emanuele & Michele, 2017). The direction of coarse roots in an urban environment, is detected to prevent them from destroying pavement and underground utility. Moreover, in construction, it is important to identify the root zone of trees to avoid bringing heavy machinery over the tree area, which can destroy the structure of the soil and roots. As a precautionary measure, detailed planning can be made for the movement of heavy machinery, a suitable location for the storage of materials, and operational safety. For forest biomass, accurate estimation of root biomass is critical for understanding carbon stocks and dynamics in tropical rainforests, and is useful for mitigating global climate change (Niiyama et al., 2010). Previous studies have shown that there is a strong positive correlation between root diameter and root biomass. A rigorous method and accurate detection of tree roots and estimation of root diameter are necessary to obtain an accurate estimate of tree biomass to quantify carbon balances in tropical rainforest ecosystems and tree root map system.

Hence, in this study, tree roots were simulated and modelled in a controlled environment to obtain the best results for analysis. Model validation is performed to determine tree root conditions. The real GPR detection was performed in the real

environment, including moisture, temperature, and soil heterogeneity, to capture random tree root detection in the field. The simulated data were then performed a comparative analysis with the real filtered data acquired from GPR. Roots and soil parameters, including dielectric constants and roots, were determined as inputs to the simulation. Normally, the soil also contains a certain amount of water (Schmitz, 2016). The analysis consists of two parts: (1) evaluating the accuracy of the simulated regression model for estimating the diameter and (2) comparing the synthetic and real hyperbolic shapes. The hyperbola fitting can be used to obtain useful information about the propagation medium (Dou et al., 2017; Mertens et al., 2016). The preprocessed B-scan helps to reduce the influences of noise, system effects, and other influencing factors (Zhang et al., 2019). Successfully detection and interpretation of tree roots can bring many benefits to surveyors, analysts, landscape architects, and more. It will be useful as a basis for future research on tree root investigation.

## DATA COLLECTION

The IDS Duo, GPR with multi-channel frequency of 250 and 700 MHz was used in this study. The target trees (*C. Japonica* tree) are large and healthy trees that can be better reflected in the radargram due to the moisture present in the roots (see Figure 1). Four roots with different trees and diameters were selected to be used as samples for the analysis. Tree roots with diameter of 7 cm, 6 cm, 4 cm, and 3 cm were detected and excavated for diameter validation. The survey line was set to be 90° perpendicular to the orientation of the root to obtain the best-reflected radargram. The dielectric constants of the roots are determined indirectly from the radargram.



**Figure 1** (a) *C. Japonica* tree (b) Example of the chosen roots

## DATA PROCESSING

The collected real data were then processed to remove noise before being used to extract the parameters. Therefore, there is no general rule for using the filter. It all depends on the data from which information is to be extracted. The real data processed includes static correction, dynamic correction, background removal, gain function, bandpass Butterworth, and diffraction stack. The hyperbola was determined, and the time interval was derived from the wiggle window as shown in Figure 2.
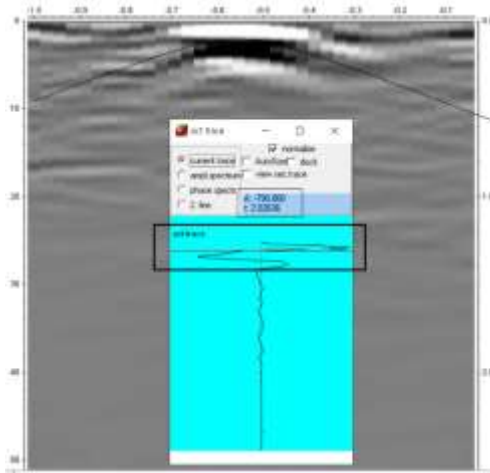
**Figure 2** (a) Time interval parameter extraction

## SIMULATION

Simulated tracking in a controlled environment was performed using GPRMax software. GPRMax is open-source software written in the Phyton language that uses the finite difference time domain (FDTD) method. In the FDTD method, Maxwell's equations are discretized into a set of equations that can be solved iteratively in time and space. FDTD provides a versatile and effective way to model electromagnetic wave motion and helps to improve survey designs and increase data interpretation.

The input and geometry are designed according to the input request file and project, as shown in Figure 3. The input must be determined characteristically and geometrically, which are the domain boundary, regional-space axis or ground, time window, the transmitter, and receiver. The time interval is the result of a series of successive radar waveforms along a particular direction, referred to as the A-scan, and a single radar track or waveform referred to as the B-scan after simulation (Benedetto et al., 2017), as shown in Figure 4.



**Figure 3** The example of input for roots 6cm for b-scan written in notepad file

In the input file Figure 3, lines 5 and 6 define two materials, soil and roots. The dielectric was set to 3 for soil and 24 for roots, while the other three numbers followed for conductivity, 1 for magnetic permeability, 0 for any magnetic loss, and finally the name of the material. Line 7 is used to set the 1.5 GHz frequency at the waveform line. Lines 8 and 9 are used to coordinate the transmitter and receiver. Meanwhile, Lines 10 and 11 set the GPR steps, which are fixed at 0.002 per second. Box, cylinder, and domain coordinates are set in another line. Figure 4 below shows the geometric view of the proposed 6 cm roots model.
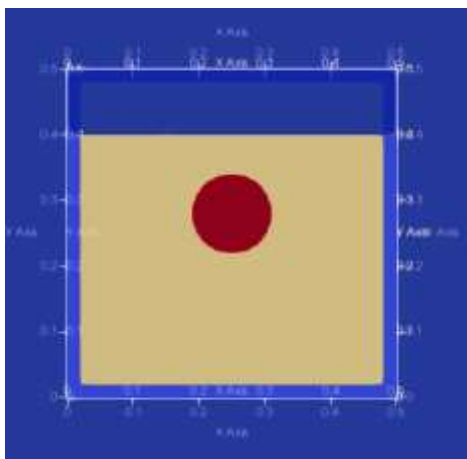
**Figure 4** The input for roots 6 cm view geometrically

The time interval derivation from A-scan and B-scan is given by

$$\Delta T = T2 - T1 \qquad (1)$$

Where ΔT is the time interval, T2 and T1 are the times recorded in the zero-field strength. This can be shown in Figure 5 and 6.
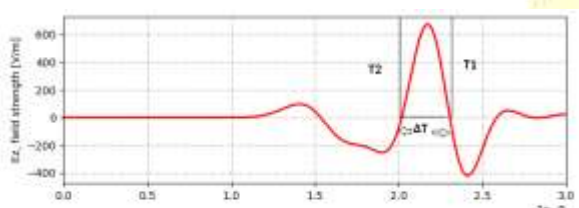


**Figure 5** The time interval extracted from the zero and Ez field strengths and marked with T1 and T2 from the A-scan for the simulation 6 cm roots.
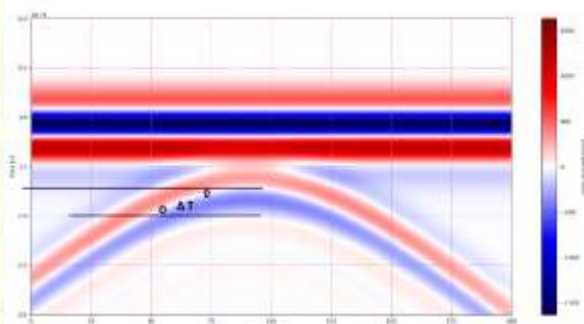


**Figure 6** Time interval extracted from zero field strength is labelled T1 and T2, B-scan for validation from the same simulation. Red indicates positive field strength and blue indicates negative field strength. The upper part is the wave reflected wave and the lower part is the result of the root scan.

## RESULT AND DISCUSSION

All parameter and results are used for analysis in this section. The comparison between the real and synthetic radargrams and the estimation of the diameter using the regression model were performed.

## COMPARISON BETWEEN REAL AND SYNTHETIC RADARGRAM

The results show that the shape of the hyperbola is quite similar in terms of amplitude and tails, as shown in Figure 7 below. It also shows a clear hyperbola for both synthetic and real radargram, which indicating the high moisture content in the real roots. The real radargram was also used in the simulation model. Through Figure 7 (b), it is clearly showing that the measurement of the root diameter was 0.56 cm. The calculation is made by as follow:

Diameter = - (-0.86) - (-0.3) = 0.56 cm.

(a)

(b)
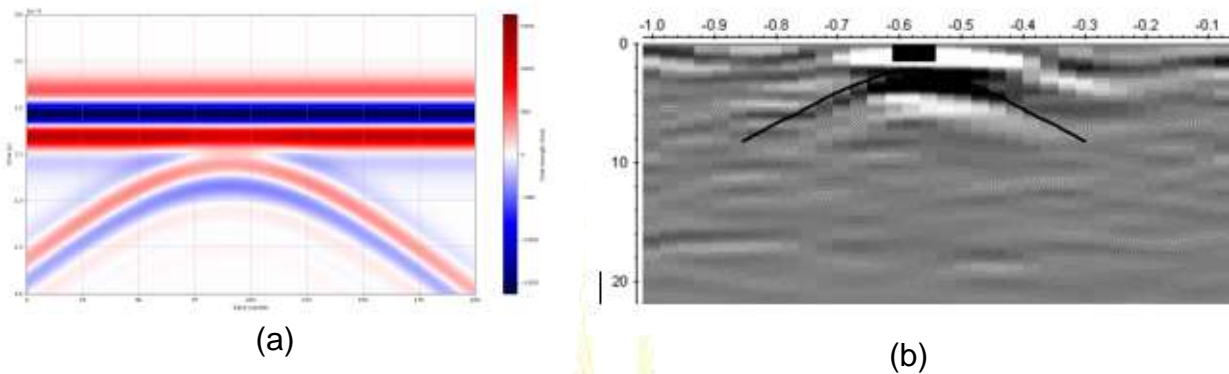
**Figure 7** (a) The synthetic radargram of 6 cm long roots simulated with GPRMax, and (b) Real radargram of 6 cm long roots

## REGESSION MODEL TO ESTIMATE THE MODEL USING THE HIGH CORRELATION BETWEEN DIAMTER AND TIME INTERVAL

For the estimation, the regression model was built using the sample data simulated by GPRMax, as shown in Figure 8. 15 roots from 4 mm until 60 mm were simulated at 2 mm intervals with the largest contrast value of the dielectric. After building the regression model, the time interval obtained from the real data was estimated. A first comparison is made with the real data obtained under optimal conditions; sand, flat surface and good humidity (Barton & Montagu, 2004). It is the most favorable condition for growth in a circumstance. Secondly, the comparison is made between the real data collected under normal conditions in Universiti Teknologi Malaysia (UTM) campus with heterogeneous and clay soil. Normal conditions mean the usual, the typical that does not require attention.
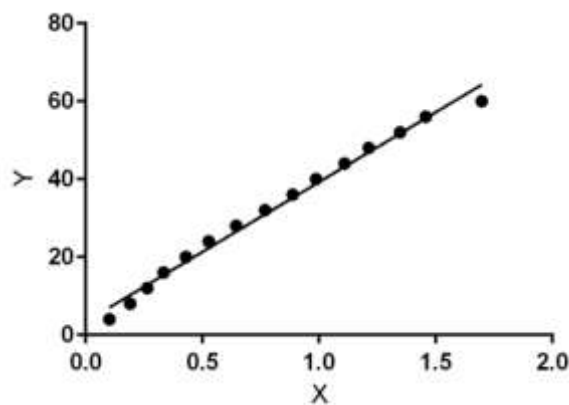


**Figure 8** The regression line model, where the x-axis represents the time interval and the y-axis represents the diameter, shows the high correlation between the two

## ESTIMATION OF REAL DATA

The results from Table 1 show that the estimation of roots under normal conditions ranges from 7 mm to 30 mm. The results show that the high correlation between time interval and diameter simulated by GPRMax under both conditions is a good estimation model.

$$Y = 35.86*X + 3.410 \quad (2)$$

Where Y is the diameter in mm, X is the time interval in nanoseconds.
This equation is used to estimate Y, the diameter from the input X, the time interval.

**Table 1** The error in estimating real data collected under normal conditions

| No. | Actual Diameter | Time interval (ns) | Estimated diameter | Error (mm) |
|---|---|---|---|---|
| 1. | 30 | 1.301 | 50.0683 | +20 |
| 2. | 40 | 1.083 | 42.2502 | -7 |
| 3. | 60 | 2.232 | 83.4569 | +23 |
| 4. | 70 | 1.040 | 40.708 | -30 |

## CONCLUSION

As a summary, the parameters derived from the simulation results are reliable and can be used for preliminary analysis and validation. For comparison and analysis purposes, the simulation uses the largest contrast values for soil and roots, which are 3 and 23, respectively. In the first part of the analysis, the signature hyperbola is quite similar in terms of amplitude and tail parameters. However, some root shapes may differ from the analysis because the value of dielectric between soil and roots is low. This means that the dried roots and small roots are hard and usually cannot be detected. The second part of the paper shows the good results of the estimation model, which benefits from the high correlation between time interval and diameter. The results show an average error of ±8 mm under optimal conditions and ±20 mm under normal conditions. The largest error was found to be -24 mm for the first result, which has the highest soil moisture content, because the high moisture in the soil reflects and scatters the electromagnetic energy, causing significant interference to the GPR signal. Beyond that, the dielectric contrast value between soil and roots decreases, resulting in a less well-defined hyperbola compared to a higher contrast value. Therefore, GPR provides an effective approach to finely imaginable tree root and soil type homogeneity, which were critical to the study of hydropedology. For further investigation, the dielectric of soil and roots can first be measured in the field to improve the accuracy of the results and the estimation model.

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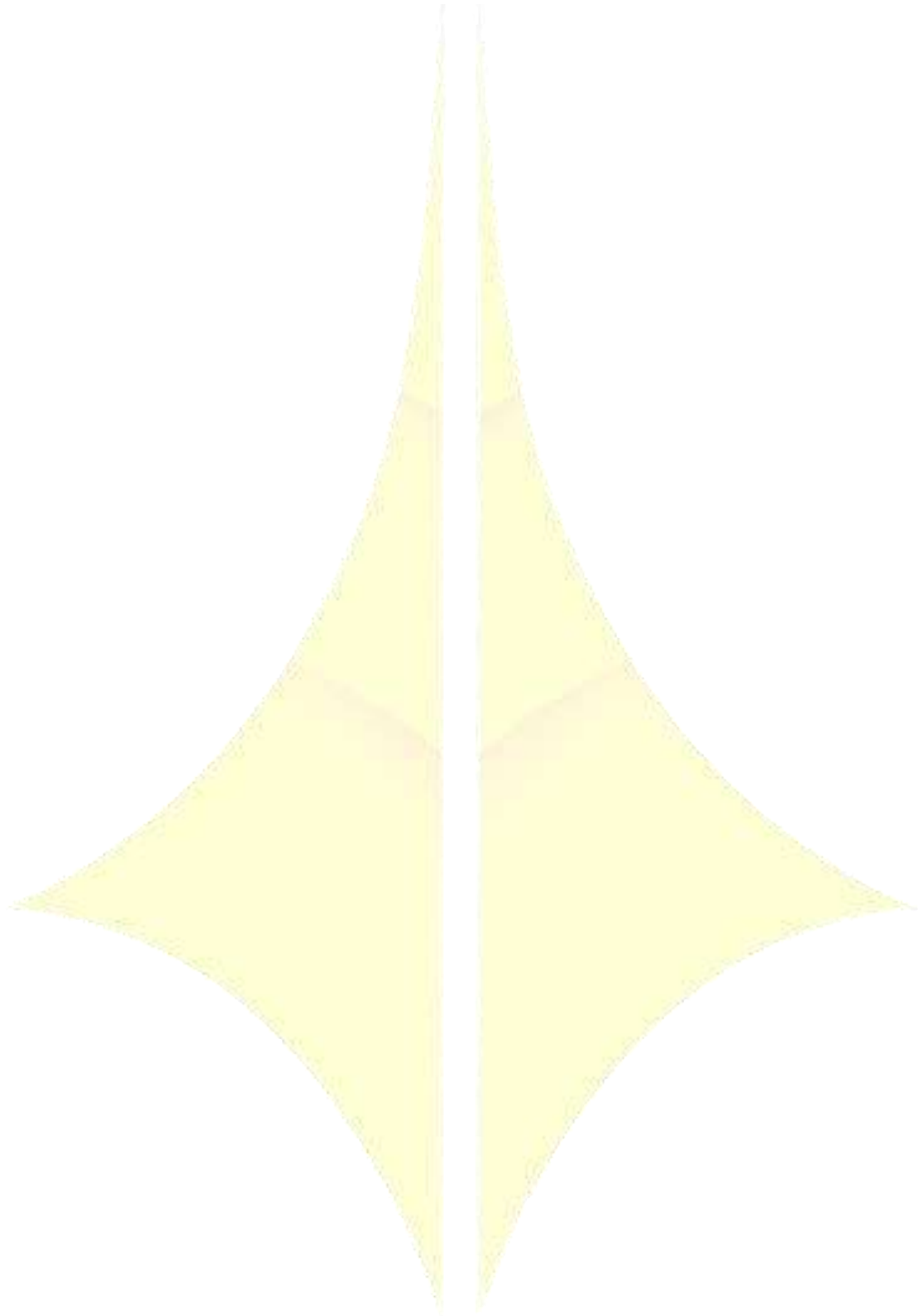
# URBAN AND REGIONAL PLANNING

# A REVIEW OF INTEGRATION OF AGENT BASED MODEL DEVELOPMENT WITH GIS IN URBAN STUDIES

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## ABSTRACT

In urban studies, agent-based modelling has become a powerful tool to simulate and understand complex phenomena. This paper presents a chronological overview of Agent-based Modelling (ABM) development in urban studies, exploring its applications with and without Geographic Information Systems (GIS) from the 1970s to 2022. The review aims to illustrate ABM techniques' development and integration with GIS, explaining their benefits and limitations in such a combined approach. Through a review of relevant studies and methodologies, this paper provides valuable information on the development of ABM research and its impact on urban studies. A knowledge gap has been identified in this report, suggesting future research directions.

*Keywords: Urban Studies, ABM, GIS, review*

## INTRODUCTION

Since the early 1950s, urban planners have depended more and more on models to understand better and forecast the effects of urban policies on land use, transportation, and people's well-being (Perez, *et.al* (2017). In urban studies, several models have been developed and applied, but most of them have been criticised frequently because most objects being modelled are not entirely understood conceptually (Cheng, *et al.*, 2003; Waddell and Ulfarsson, 2004; Pinto and Antunes, 2007; Liu *et.al.,* 2020; Bibri *et.al.,* 2020). Rakodi (2001) argued that improving planning quality is an attempt to improve understanding and analyse the interrelated components of urban development processes. The deficiency in current modelling approaches does not allow us to understand the complexity of urban growth in detail. Progress in modern Geographic Information Systems (GIS) tools and techniques also contributes to the thrust of this study. Using GIS tools opens new possibilities for accessing information, more accurate data analysis and generating alternative development scenarios. Combining GIS tools with urban growth and land use pattern models offers advantages to decision-makers.

Planning and rapid development, especially in the urban centre of trade and tourism, may pose various challenges and problems in implementing the plans. This challenge needs to be considered by decision-makers, especially in determining the direction of the development in terms of urban development, in providing a

complete infrastructure and raising the country's economy. To ensure the achievement of the plan, the use of Agent-based Modelling (ABM) is an approach that might contribute to solving this problem (Crooks *et.al.*, 2017). An agent-based model is a form of computational social science which involves models that are computer programs (Gilbert, 2008). Axelrod and Tesfatsion (2010) also stated that ABM is suited for social science as ABM is applied to social processes using concepts and tools of social science and computer science. It represents a methodological approach that could ultimately permit two essential developments: (1) the rigorous testing, refinement, and extension of existing theories that have proved to be challenging to formulate and evaluate using standard statistical and mathematical tools and (2) a deeper understanding of fundamental causal mechanisms in multi-agent systems, whose study is currently separated by artificial disciplinary boundaries (Chen, 2012). Therefore, it is crucial to urban and regional planning; thus, urban planners are the right people to investigate spatial models contributing to space-related development and examine the assumptions and theories that trigger it. Previous researchers have classified ABM as a new wave of urban modelling (Torrens, 2002) due to its ability to address some of the weaknesses of urban planning models.

By providing a chronological review of ABM development in urban studies and its integration with GIS, this paper aims to enhance understanding and foster innovative research in the field. The insights gained from this review can be valuable for researchers, policymakers, and practitioners involved in urban planning, spatial analysis, and urban policy formulation.

## INTEGRATION OF GIS AND ABM

The agent-based modelling approach is responsive to incorporate the effect of parameter values, rule-based and interactions with the environment. The representation of the environment involves describing spatial properties, making GIS a useful tool for ABM (Manson *et.al.*, 2020; Crooks *et.al.*, 2017). GIS is thus a powerful tool which allows mapping, querying, modelling, analysing and displaying data within a single database. In local planning authorities, GIS is used at various points in the planning process, including analysis and synthesis-oriented tasks such as plan development and evaluation. With its powerful capacity for spatial data management, spatial analysis, and visualisation, GIS provides planners with new means to implement their work more efficiently. GIS opens new possibilities for accessing information and more accurate data analysis and helps generate alternative development scenarios. Theoretically and practically, it would constitute a step forward in modelling if the ABM could access GIS data.

Through the integration, researchers can incorporate detailed real-world environmental data to simulate agent behaviours and processes as change and movement conditioned by GIS data representations of space and geography and to visualise the results in 2D or 3D GIS environments (Li, 2001). Furthermore, agent-based models can comprise real-time GIS data feeds to simulate and visualise situations unfolding in real time. ABM incorporating spatial factors, for example, traffic simulation, is more successful because it is an easily verifiable, understandable result due to visualisation and better confident results (Salamon, 2011). Thus, GIS that incorporates spatial data entities could be easy to be applied with ABM. The multiple representations of spatial data in raster and vector GIS will combine the advantages of spatial disaggregation (raster) and efficient network algorithm (vector) (Schürmann *et.al.*, 1997).

As noted, planning authorities already widely use GIS to improve their work. Other components could be added and

integrated with GIS to strengthen its capabilities. It is argued in this thesis that Agent-Based (AB) technology is an essential and relevant candidate. AB can strengthen two key purposes: simulation and problem-solving (Ferrard, 1996). GIS will provide geospatial information to restrict agents' behaviour within the study area, such as land uses, transportation, amenities, and other related data for analysis. A sketch illustrating the

integration between ABM and GIS is shown in **Figure 1**. GIS technologies are beneficial for this study for two main reasons. First, GIS would allow agent-based modellers to relate agents to actual geographic locations. Thus, integrating GIS and ABM would enhance the capability of urban simulation techniques (Brown *et.al.* 2005; Parker, 2005; Torrens and Benenson, 2005).
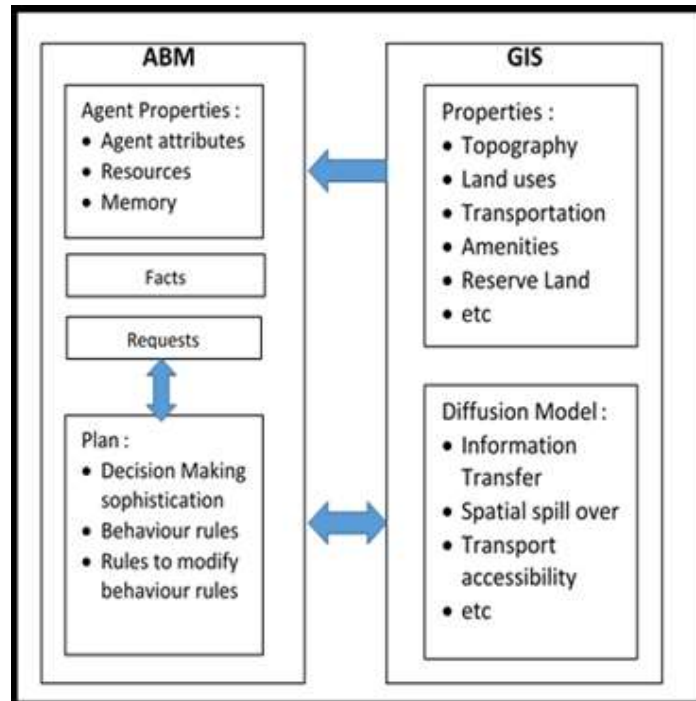


**Figure 1** ABM-GIS Integration
Source: Modified from Guo *et.al.* (2008)

Urbani and Delhom (2008) claim that the integration of GIS and ABM opens the following capabilities:

(a) Makes available a considerable amount of data and information produced and used by users who commonly employ GIS. Thus, it is suggested that constructing the ABM-GIS model will facilitate researchers familiar with the GIS paradigm (Gonçalves et al. 2004).

(b) ABM paradigm used to consider the process(es) at work in each situation.

(c) This approach enables the model builders to validate the dynamic models by comparing massive simulation data with field observations.

(d) Facilitates cooperation between stakeholders and decision-makers

and thus improves the results of decision processes.

(e) ABM-GIS integration allows the creation of models directly related to space and provides a new way to explore urban dynamics at various spatial and temporal scales.

## METHODOLOGY

This study employs a structured methodology to provide a comprehensive chronological overview of Agent-based Modeling (ABM) in urban studies, focusing on its integration with Geographic Information Systems (GIS). The methodology includes a thorough literature review covering works from the 1970s to 2022, emphasising seminal

contributions and significant advances in ABM within urban studies with and without GIS. Various data sources were used, including academic databases (e.g., IEEE Xplore and Google Scholar), relevant journals, conference proceedings, and books. Targeted keywords such as agent-based modelling, urban studies, geographic information systems, and related terms guided the targeted search. The data collected was subjected to rigorous review to ensure its relevance, considering the availability of full-text articles in reputable publications. The selected articles were systematically organised chronologically to create a timeline illustrating the progress of ABM in urban studies. A comprehensive and systematic analysis was conducted to identify prevailing trends, key milestones and changes in ABM applications, focusing on studies highlighting GIS integration. The results were presented in a coherent chronological narrative format to provide readers with a historical perspective on the development of ABMs in urban studies with and without GIS.

## CHRONOLOGY OF ABM DEVELOPMENT IN URBAN STUDIES WITHOUT AND WITH GIS

The employment of Information and Communication Technology (ICT) is seen as an evolving approach to improve urban governance. As noted above, GIS is one functional manifestation of ICT that could build complex and exciting spatial models representing urban development patterns. However, that may take some effort as their script languages could be better in this regard. At the very least, however, geographic information systems are highly appropriate for spatial data handling and visualisation of model output (Davis, 2001). Geo-reference is the most crucial feature of GIS, and this functionality is very useful for spatial modelling. Applications based on spatial reference will create better geo-simulation (Benenson and Torrens, 2004). Meanwhile, multi-agent

systems can represent the processes underlying a particular phenomenon or activity.

Thomas Schelling's (1971) landmark experiment from the 1970s demonstrates the racial housing segregation patterns using ABM in American cities. It has since shed light on the widespread use of ABM in related fields. The expansion of ABM in urban studies was notable 20 years later, in the 1990s. In 1994, Drogoul and Ferber explored emergent phenomena in cities from a broader perspective. The first large-scale agent model was Sugarcape, developed by Epstein and Axtell in 1996. The model replicates paradigmatically simulated social behaviours such as aggregation and segregation, a similar track by Schelling. In the late 90s, Benenson (1999) modelled the urban population dynamics in the city area. His model is focused on the approach to understanding macro-processes that arise from micro-level interactions. Gilbert and Terna (2000) see the potential of ABM in social science simulation. With computer simulations, unlike other methods, they discover it can formalise complex theories of processes, perform experiments and observe occurrences in presenting social phenomena. In 2002, the use of ABM expanded to urban studies involving land use and transportation. The studies involve traffic simulation (Barrett *et.al*, 2001) and pedestrian movement in the city centre (Haklay *et.al*, 2001). Parker *et. al*, (2003) performed a comprehensive review of the application of ABM in land use change and land cover modelling, with more research being added afterwards by Huigen (2003); Kii and Doi (2005); Manson (2006); Rindfuss et al., (2008). Other research on urban studies using ABM are on urban and residential locations by Torrens (2006), human behaviour in complex adaptive systems (Torrens & Nara, 2007) and Gentrification (Jackson *et.al*, 2008).

Starting from the early 21st century, as geographic information systems have advanced, ABM has come to be

considered a powerful instrument for spatial modelling and geospatial analysis. **Table 1** provides a development of ABM development in urban studies with GIS. It shows the various studies integrating ABM with GIS, especially after 2000. This suggests that various land use issues and municipal studies can be modelled to see how the model can mimic realistic current conditions.

**Table 1**: Chronology of ABM development in Urban Studies with GIS by year

| Year | Urban Studies Topic | Sources |
|------|---------------------|---------|
| 2002 | Geosimulation | Jiang & Gimblett |
|      | Residential Location | Benenson et al |
| 2003 | Public event | Batty *et.al* |
| 2004 | Disease propagation & urban traffic | Eubank *et.al* |
| 2006 | Retail | Heppenstall et al |
| 2007 | Crime | Groff |
| 2010 | Urban Shrinkage | Haase *et.al* |
| 2011 | Flooding | Dawson *et.al* |
|      | Surveillance for Dengue case + geosocial | Gomide *et.al* |
|      | Informal Settlement Growth | Augustijn-Beckers *et.al* |
|      | 3D Cityscape | Crooks *et.al* |
| 2012 | City systems | Pumain |
|      | Office Firm Dynamics | Manzato |
|      | Gentrification | Sabri |
| 2013 | Riots | Torrens and McDaniel, |
|      | Disease Propagation | Crooks and Hailengiorgis |
| 2014 | Regeneration | Jordan *et.al* |
|      | Urban growth | Xie & Fan |
|      | Human movement and activity in city + geosocial | Wu *et.al* |
| 2015 | Land use change in urban renewal district | Zheng *et.al* |
|      | Residential Mobility | Perez et,al |
|      | Disaster diffusion pattern geosocial | Rand *et.al* |
| 2016 | Flood risk communication + geosocial | Haer *et.al* |
| 2019 | Enhance Urban planning and land monitoring model | Qi *et.al* |
|      | Socioeconomic drivers + geosocial | Jiang *et.al* |
| 2020 | ABM-learning for residential land growth | Li, *et.al* |
| 2021 | Urban Life Agent-Based Simulation | Züfle *et.al* |
|      | Post-disaster recovery | Ghaffarian *et.al* |
| 2022 | Urbanisation policy + participatory planning | Liu *et.al* |
|      | Mesa-Geo = ABM+Phyton+GIS | Wang and Crooks |

Advanced from urban studies, ABM may also be used in urban systems as a helpful tool for representing mobile entities in urban environments, such as people, households, and vehicles. They have been used in urban contexts to simulate pedestrian movement in urban environments (Knura, 2019; Kerridge et al. 2001) and relocate households (Benenson, 1998). Progressively, ABM is becoming recognised as the most helpful method for simulating the processes and forces in a geospatial systems environment. It presents the alluring prospect of producing new perceptions and information about how geographical

systems have developed to their present condition and how they can advance in the future.

## CONCLUSION

The capabilities of GIS software systems contain practical tools for acquiring, pre-processing, data transformation, visualisation/mapping, rendering, querying, and analysing model results (Crooks and Castle, 2012). However, integrating it with ABM is still a complex and challenging process. Agent-based models have the potential advantage that simulations can be more firmly based on the behavioural patterns of the actors as opposed to statistical data related to spatial units of observation. Two critical issues in coupling agent-based modelling with GIS are implementing spatial awareness of agents in geographic space and integrating the dynamics of the environment and its impacts on the agents' behaviour.

There are numerous considerations and hurdles to overcome in the integration, which is the data. It is traditionally difficult to find good-quality data to evaluate a complex model properly (Crooks *et.al.* 2018). However, nowadays, the emergence of big data and the associated data from social media has directed to the production of sensitive individual-level data (*Mayer-Schönberger* and *Cukier,* 2013) that have the potential to transform the quality of agent-based models.

Since human decision-making and interaction are the core components of ABM, successful integration of GIS and ABM will ideally aid town planners and decision-makers in identifying characteristics that will contribute to growth in a region. Concerning this, it will assist those involved in urban development (policymakers, urban planners, and other experts and administrators) in understanding urban planning development and making informed decisions. As a result, the combination of GIS and ABM would enhance the ability to simulate urban dynamic development. It would allow users to simulate, display, analyse, and present data on a single platform.

After discovering the capability of integrating ABM and GIS, the possibility gap for future study is to design the exact model on other models for urban studies, such as urban densification and not replicate the existing models. With the urban densification approach and the development of land use models, ABM and GIS paradigm could be a powerful integration tool for urban dynamic interaction in urban areas.

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# A REVIEW OF CHINESE IMMIGRANT FOR MALAYSIA AS A MY SECOND HOME'S PREFERENCE

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## ABSTRACT

This paper aims to conduct a systematic literature review in order to analyze the phenomena of retired immigrant especially Chinese immigrant in the context of the research. Lately, retired immigrants have brought an increase in revenue not only in tourism as well as the real estate investment. The investment in immigration at the destination can beneficial the tax revenue of the destination government and lead to more trade opportunities. In line with the cultural exchange between the two countries, it is an important part of the people-to-people exchange. Therefore, this paper aims to study (1) the research trends of retired immigrants in the background of tourism, (2) the issues focused in this particular topic and (3) the arguments and critical findings from the past research. Through the meta-analysis, the review findings disclose that after 2014, the research trend gradually shifted from e Americas and Europe to Southeast Asia. While, the findings also reveal that migration motivation, satisfaction and preferences are the domains favoured in examining the retired immigrants in the setting of tourism research. On the other hand, certain retired immigrants believed that climate is the first reason of migration yet some perceived that family reunion is the most critical reason. All in all, this review paper provides a comprehensive understanding of retired immigrants especially in the tourism immigration environment.

*Keywords : Retired immigrants, Chinese immigrant, Tourism immigration*

## INTRODUCTION

Malaysia is a tourism powerhouse in Southeast Asia, with about 25.83 million visitors in 2018, growing to 26.1 million in 2019, bringing RM86.14 billion in tourism revenue to the local government, accounting for 15.9% of its gross domestic product (GDP). Among them, there were 2.94 million Chinese tourists in 2018, and tourism consumption accounted for 14% of the tourism economic income (X. Chen et al., 2020). Malaysia has taken a series of measures to stimulate the recovery of the tourism industry, which has suffered a significant decline due to the impact of the COVID-19 pandemic. Chinese tourists are the typical development objects of Malaysia's tourism industry, and a large

number of scholars have conducted in-depth exploration from the aspects of demand, motivation, destination perception and tourism characteristics (Cao et al., 2022), in order to speed up the recovery of Malaysia's tourism industry.

The purpose of this study was to measure the interaction between Chinese citizens and My Second Home Program in Malaysia.

The research questions are broken down into the following: (1) Why do Chinese citizens choose Malaysia for retirement? (2) What are the background and residence preferences of Chinese immigrants in Malaysia? (3) What governance policy framework can the government provide for the My Second Home Program in Malaysia based on the expectations of Chinese citizens?

## Literature Review

Economic globalization and the rapid development of aviation technology have shortened the distance borders between countries, making the development of transnational communities possible. According to the World Migration Report 2022, published by the International Organization for Migration (IOM) of the United Nations. The report is more than 500 pages long and authoritative because it was issued by the United Nations. The initial phase of the COVID-19 pandemic greatly affected the flow of migrants, and as the epidemic is greatly eased, the number of migrants will see a new peak. Despite disruptions to global mobility caused by the pandemic, nearly 282 million people were still living in a country other than their country of birth in 2020, about 128 million more than in 1990 (153 million) and more than three times as many as in 1970 (84 million). The report showed that India became the country with the largest number of emigrants, more than 15 million. Mexico came in second, with Russia and China three or four places apart. In terms of emigration, India has the largest number of emigrants in the world, with nearly 18 million people living abroad.

Mexico is the second largest source of immigrants, with about 11 million; Russia is third, with 10.8 million; China is the fourth largest source of immigrants, with about 10 million.

In China, 10 million people have emigrated abroad, which is equivalent to one out of every 140 people they know. In big cities like Beijing, Shanghai, Guangzhou and Shenzhen, one out of every 100 people has overseas status! According to the data released by the National Immigration Administration of China on immigration management in the third quarter of 2022, more than 22.185 million people entered and exited China. The Chinese are present all over the world, with Indonesia currently having the largest Chinese population of more than 10 million, followed by Thailand (7.01 million) and Malaysia (6.72 million). At present, China has entered an aging society. In 2020, there will be 264 million elderly retirees over the age of 60, who have a strong willingness to live overseas and plans to buy properties. Malaysia has a beautiful environment and low cost of living, which is suitable for old-age living.

Malaysia also has the third largest Chinese population, after Indonesia and Thailand. Malaysia federal & state governments projected a high economical values towards the MM2H project, which estimated to contribute significant to the country's GDP. At the same time, the cultural backgrounds of China and Malaysia are similar, and the language barrier is low. According to the Foreign Ministry's Malaysia country profile document, Malaysia's population was 32.4 million (1.8 million in the capital Kuala Lumpur) at the end of 2018. Of these, 69% were Malays, 23% Chinese, 6.9% Indian and 1.0% other races. Malay is the national language, English is widely used and Chinese is widely used.

Beyond that, Malaysia's total export value exceeded 1.5 trillion Ringgit for the first time in 2022, achieved the 12th Malaysia Plan three years ahead of schedule. The value of imports was close to 1.3 trillion

Ringgit, breaking the 1 trillion Ringgit mark for the first time. Bilateral trade reached a record high of $203.6 billion in 2022. The year 2022 will mark the beginning of China-Malaysia relations, and 2023 will mark the 10th anniversary of the establishment of the comprehensive strategic partnership between the two countries. Malaysia's imports and exports reached a record high of more than 2.8 trillion ringgit (4.24 ringgit per US dollar) in 2022, according to data released by the Malaysian Foreign Trade Development Council on Monday. According to the statistics of China Customs, the import and export volume of bilateral goods between China and Malaysia in 2022 was $20,359,231,500, which increased by $26,785,818,700 compared with the same period in 2021, with a year-on-year growth of 15.3%. The latest cooperation will definitely increase bilateral relationship that allowing potential housing ownership by Chinese citizen due to the increase business profile between two countries.

Salami et al., (2023) examined the Turkish real estate market requires sustained policy intervention, as housing prices play a key role in Turkey's economic development and daily life. Foreign housing acquisitions had a negative impact on housing affordability in Turkey and called for intervention by the authorities. Identifies the impact of foreign housing acquisitions on the rise in house prices in Turkey and adversely reduces the affordability of housing for Turkish citizens.

Shakur et al., (2021) studied the Malaysian city of kajang and found that home ownership is one of the key factors in achieving the livability principle of a livable city. In addition, there are many other factors that affect homeownership, including income, location and accessibility factors. His Government had discussed various issues to address concerns about home ownership, particularly for the low - and middle-income groups in many Malaysian cities. The findings show that the main factors influencing home ownership are income, home loan scheme, location, government

role, developer role, PR1MA affordable housing scheme, construction cost, Indigenous quota, lifestyle, quality of life, real estate investment and transfer, assessment/property tax, land ownership and ownership by foreigners.

Andy Hartanto (2018) conducts his research by researching and analyzing legal materials and issues related to the research question. The principle that Indonesian citizens grant high-level property rights to foreigners. The ownership of a foreigner's bungalow is based on a right to national land, which is a land right that foreigners residing in Indonesia can have. While in Soul, Kim examined the foreigners who buy houses in Seoul and where are the houses owned by foreigners. (Kim et al., 2015)By analyzing housing transaction data and the location of ethnic communities, this paper shows that foreign residential investment in Seoul is closely related to overseas Koreans, rather than general global talent or immigration. The location of foreign-owned houses is linked to the location of ethnic minority concentrations and areas considered to have a high potential return on investment. Foreign investment in housing has the potential to strengthen the long-term settlement of foreigners and encourage the emergence of a "global village".

Lord & Gerber, (2009) found that for a small country like Luxembourg, stability and economic growth depended on immigration. Immigrants need to be integrated into the housing market. Luxembourg's housing market is characterized by high prices for either purchased or rented residences. The single-family property is also becoming the "dominant housing model." Home ownership is easier to acquire for highly qualified foreigners and for nationals independent of their level of qualification. Having said that, less advantaged families, especially foreigners, face more difficulties in integrating into society. The government's housing support scheme has facilitated the entry of disadvantaged families into the housing market. However,

the same housing plan leads them to "dominant living mode".

In 2022, the total value of China's exports to Malaysia was $9371.2516 million, an increase of $14,969,2719 million compared with the same period in 2021, with a year-on-year growth of 19.7%. The total value of China's imports from Malaysia was US $10,987,899,900, an increase of US $11,816,546,800 or 11.8% compared with the same period in 2021. Malaysia's Prime Minister Anwar Ibrahim said in his keynote speech at the Invest Malaysia 2023 Forum in Kuala Lumpur on March 8 that China is a key engine for economic growth and an important economic partner for Malaysia. In 2023, the global economy will still face the challenges of slowing growth and inflation. China is a key economic engine and an important economic partner for Malaysia. China was Malaysia's largest source of foreign investment in 2022, with a total of 163.3 billion ringgit (4.43 ringgit per US $) approved for foreign direct investment (FDI). Investment from China reached 55.4 billion ringgit, accounting for 33.9%, according to a report released by the Malaysian Investment Development Authority on March 8. According to Chinese Customs statistics, bilateral trade volume in 2022 was US $203.6 billion, up 15.3% year on year. China has been Malaysia's largest trading partner for 14 years in a row.

The head of Malaysia's Foreign Trade Development Board said the country will continue to promote exports under the three major plans of "digitalization", "sustainable development" and "National Trade Blueprint". In 2023, the administration will promote a number of "high value export initiatives", focusing on supporting export industries such as electrical and electronics, mechanical equipment, aerospace equipment, food and beverage, pharmaceuticals, construction materials, oil and gas, information and communications technology and shipbuilding. Tourism is Malaysia's third-largest economic pillar, after electronics and oil and gas, and is the

country's second-largest foreign exchange earner, ahead of the oil and gas industry, according to official data. Meanwhile, tourism and related industries in Malaysia employ more than 3.52 million people, accounting for more than 23% of the country's total employed population. This is why the Malaysian government has been working to promote Malaysia as a top destination for global tourists. Tourism is important to Malaysia in many ways, both as an important source of foreign exchange and job security for its citizens. Three years of COVID-19 have taken a huge toll on Malaysia's economy, with tourism suffering the worst. According to Statistics Malaysia, the number of inbound tourists to Malaysia in 2020 was down 83.4% from 2019, the worst ever drop in the country's tourism industry. Only 4.3 million tourists visited China in 2020, compared with tens of millions before the pandemic. During the epidemic, travel agencies, accommodation and other industries suffered massive losses, resulting in job losses and business closures. Statistics show that Malaysia is expected to lose 165 billion ringgit (255.7 billion yuan) in tourism revenue in 2021. Until now, a weak economy, poor employment and rising prices have been the problems plaguing Malaysia's economy.

On February 6, 2023, the Ministry of Culture and Tourism of China issued a notice to resume the pilot operation of Chinese travel agencies and online tourism enterprises to operate outbound group Tours for Chinese citizens to multiple countries, including Malaysia. Malaysia's tourism industry is projected to buzz. From government departments down to employees, travel agencies, hotels and restaurants are all starting to prepare for the coming Chinese tourists. Malaysia's multi-cultural tourism industry attracts tourists from all over the world through its long history, unique cultural traditions, beautiful scenery and rich cultural heritage. It is a combination of natural exploration, gastronomy, cultural heritages or shopping holiday. Last but not the least, the recovery of tourism industry

after the pandemic is a great significance to revitalise Malaysia's economy.

In the January-March 2023 period, Malaysia attracted 4.38 million foreign tourists, of which 178150 were Chinese tourists, accounting for only 4 per cent, but an increase of 4,915 per cent compared to the first quarter of last year (3,624). According to data provided by Malaysia's Tourism Ministry, there were 975, 1,209 and 1,440 Chinese tourists in January-March 2022 (3,624 total), and 45,317, 49,782 and 83,051 tourists in January-March 2023 (178,150 total). In the first quarter of this year, the number of Chinese tourists to Malaysia only recovered 21.16% compared with the pre-epidemic figure (compared with the figure in the first quarter of 2019), but still showed a momentum of monthly increase. In particular, the figures of March almost directly doubled from February. As time goes by, Chinese tourists to Malaysia will gradually recover.

## Methodology

The research method is usually to issue a questionnaire first, followed by an interview. Before the mass distribution of research, there is a pilot questionnaire. The following interviews generally lasted an hour each(Abdul-Aziz, Loh, et al., 2014). Some interviews were flexible, ranging from 45 minutes to 90 minutes. The research time was also long, from June to November 2011. Certainly, some interviews are in-depth interviews to explore more information by means of snowball sampling (K. M. Wong & Musa, 2014, 2015).

Meanwhile, some software is also used in the Survey, such as Survey Monkey website (B. K. M. Wong et al., 2017). Data was collected using multi-method(i.e. interviews and secondary sources) and multi-source (i.e. multiple parties for interviews and multiple channels for secondary sources (Abdul-Aziz et al., 2015).

K. M. Wong & Musa (2015) used NVivo software together with field notes and audio-taped informal conversation in the data analysis method. The data was triangulated with several primary and secondary sources. VEP techniques have also been used for capturing affective elements (Jaafar et al., 2020).

As these immigrants protect their privacy and do not want to be disturbed, the sample size is also a difficult problem in MM2H research, which is generally less than 50. 30 interviews and 23interviews (K. M. Wong & Musa, 2014, 2015), 41 questionnaires and 10 interviews and 47 interviews respectively due to MM2H dwellers reclusive (Abdul-Aziz, Jaafar, et al., 2014; Abdul-Aziz, Loh, et al., 2014). Ullah et al. (2021) conducted 27 interviews by using WhatsApp, email and phone calls. A small number of scholars have collected a large number of questionnaires:384 international tourists (Jaafar et al., 2020), B. K. M. Wong & Musa (2017) used the empirical analyses and collected 504 questionnaires and obtained a mass of data due to the large number of data collection centers.

## Malaysian in the context of Chinese Citizen and Tourists

Malaysia is very popular among Chinese citizens. Malaysia is an attractive country mainly because of its low language barrier, suitable climate, friendly international relations, lack of natural disasters, and real estate investment. Malaysia's location means it boasts a good living environment, low cost of living, convenient healthcare and market shops. But at the same time, the study also found that climate is not the most important factor to attract immigrants, exchange rates also affect the decision to move. Malaysia's social mores and poor driving habits will dampen demand.

Malaysia is a multi-racial, multi-lingual and multi-cultural country. Of the more than 30 races in the country, Malays, Chinese and Indians are the three most populous. Of these, Malays make up about 68 per cent,

Chinese about 23 per cent and Indians about 7 per cent. At the national level, Malay is the national language and the official language of Malaysia. Due to its history as a British colony, English is the international language used by all ethnic groups in Malaysia, while Chinese is the common language of the local Chinese. It is no exaggeration to say that Malaysia is the only country other than China that has a good command of Chinese language, and is the only country other than China that has a complete Chinese language education system, from primary school to secondary school to university, seamlessly. On the one hand, the special language education policy and historical background are inseparable from the edification of social environment and the promotion of work demands. Therefore, Chinese tourists and Chinese immigrants can communicate in both Chinese and English in Malaysia with fewer language barriers.

Malaysia is located near the equator, belonging to the tropical rain forest climate and tropical monsoon climate, there is no obvious four seasons, the annual temperature difference is very small, the average temperature between 26 and 30 degrees, abundant rainfall throughout the year. Although the day is hot, but afternoon showers, the evening will have monsoon blowing, very cool, especially in

## CONCLUSION

There is a limited amount of literature on retired immigrants, and the dynamics surrounding these studies are work on travel motivations, migration reasons, immigrant satisfaction, etc. Taking the tourism and immigration issues in Malaysia as an example, it is necessary to fully understand the situation of retired immigrants. This is because Malaysia has become a welcoming country for immigrants. The results show that the motivation of immigrants and the satisfaction of immigrants are the main areas of research on retired immigrants. At the same time, the research trend of retired immigrants began to shift from

the north of Penang Island, morning and evening climate is suitable, cool breeze constantly. Travel in Malaysia is basically year-round. In terms of environment, Malaysia is known as "retirement paradise". Malaysia is located in the tropics and has a tropical Marine climate. It is warm all year round, with a small temperature difference and an average temperature of 26-29 degrees. There is no obvious change in four seasons, so it is very suitable for living.

China and Malaysia are traditional friendly neighbors. China attaches great importance to its friendly relations with Malaysia, which have maintained a sound momentum of development. China believes in and wishes Malaysia to maintain stability and development, and stands ready to work with Malaysia to promote the sustained development of China-Malaysia comprehensive strategic partnership, so as to benefit the two peoples and promote regional stability and prosperity. Malaysia and China established diplomatic relations as early as 1974, and the friendly relations between the two countries have deepened over time. The depth of the friendly relations between the two countries can be seen from various aspects, such as economy, culture and education.

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American countries and European countries to Southeast Asian countries, and there were different preferences among Southeast Asian countries. Some people point out that cultural attraction, natural environment and climatic conditions constitute important factors of satisfaction among retired immigrants. Finally, it is suggested that a future study be conducted to address the reasons, background and policy support for immigration from many countries through the lens of Malaysian immigration. This will help the Malaysian government continue to enhance its appeal as a country of immigrants.

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# A SYSTEMATIC REVIEW OF FACTORS AFFECTING EQUESTRIAN PLANNING IN TOURISM

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## ABSTRACT

This paper reviews the systematic literature on the factor affecting equestrian planning in tourism. This study seeks to comprehend the present level of understanding about equestrian planning including identify the elementary factor affecting equestrian planning in tourism. There is deficit in the multidisciplinary approach to equestrian planning in tourism, as well as the factors influencing the context. Qualitative content analysis was utilized in a systematic literature review, and the study had to be sufficiently described for the results to be easily replicated. For this review, 50 research publications from the Scopus and Google Scholar databases were analyzed. The selection process implements the PRISM screening techniques and choose keywords from relevant publications in high impact journals that provided pleasing results and fascinating ideas for additions. The expectation of this review is to gather the diversity of factor that might affect the development of equestrian tourism. Hence, the findings indicate the growing interest and significant interest in research of equestrian planning that mostly located in Europe. Therefore, this paper outlines knowledge gaps in the literature as well as prospective research objectives that may be studied by experts in the field of equestrian tourism.

*Keywords : equestrian planning, equestrian tourism, equine operators, equestrian product*

## INTRODUCTION

### Equestrian Planning

Equestrian planning is a lifestyle industry that involves creating and managing equestrian facilities and activities to ensure the safety and welfare of horses and riders while addressing environmental and social impacts (Sigurdardottir & Steinhorsson, 2018). With the rising demand for urban tourism, equestrian tourism activities are becoming the preferred choice for visitors to appreciate local scenery (Bunchmann, 2017). Operators can meet demand by analyzing customer satisfaction and understanding equine tourism operations (Dashper, Helgadottir, & Sigurdardottir, 2021). Furthermore, equestrian planning is crucial for developing new tourism products for regions or states, aiming to create sustainable and engaging experiences for riders while promoting economic and cultural benefits to local communities (Tolls & Carr, 2020; Pavic,

Blesic, D. Petrovic, M. Radovanovic, & Prisenk, 2019).

It is sufficient to emphasize that each region should have a fundamental tourism strategy that emphasizes horse travel in order to solve tourism-related issues (Hjalager, Kwiatkowski, & Larsen, 2017). Therefore, the goal of this study is to fill the information gap by using a systematic literature review methodology, followed by a presentation of equestrian planning. In line with this, this systematic literature analysis will emphasise what is known and what future researchers need to know in order to discover key contributions in the field of tourism. This review would also be helpful to equestrian operators to enhance their equine centre and services, and to assist from their policy, practise, and perception regarding equestrian planning.

### The Importance of Equestrian Planning in Tourism

Planning is essential in equestrian tourism because it maximizes its advantages, stimulates the economy, and reduces any potential problems (Hjalager, Kwiatkowski, & Laersen, 2018). Before beginning an equestrian event, it's crucial to make a strategy (Fredman & Margaryan, 2020). Unplanned planning in equestrian tourism frequently results in social and environmental issues, as well as low appeal benefits in a particular place (Shoval, 2018). Since problem-solving is the foundation of tourist planning, planning processes should be able to offer conceptual vision given the significance of taking context into consideration while developing solutions (Rahmafitria, Pearce, Oktadiana, & Putro, 2020). The significance of tourism planning, in accordance with Shoval (2018), will develop attractions in certain areas and ensure that they continue to be attractions in the years to come. Hence, equestrian tourism requires careful planning at all times because it should last for a very long period and has the ability to evolve in many different directions (Hjalager, Kwiatkowski, & Laersen, 2018).

### The Current issue in Equestrian Planning

The issue that remains unsolved are about planning in equestrian tourism. It is a part of the main reasons why the operators failed to offer the best equestrian experience, especially in trail ride track, welfare of the horse, and customer service (Tolls & Carr, 2020; Helgadottir & Sigurdardottir, 2020). A long-standing issue in the equestrian tourist industry is the issue of the equestrian center's poor profit margin. Buchmann (2017) highlight the issues that still deficiency in attention regarding the accessibility for tourists, as well as a type of infrastructure existing on the trail that should be considered. Some expert in equestrian tourism research found out operators who ignoring the basic process of planning unable to encourage more tourist to try the tourism product and failed to develop equestrian tourism for a country (Cernaianu & Sobry, 2019; Sigurðardóttir & Steinthorsson, 2018; Notzke, 2017).

### The Aim of the Review

Literature review will be used as a methodology to address the deficit in the multidisciplinary approach to equestrian planning in tourism with the valid literature from expert in the equestrian tourism industry. The aim of this review to identify the main factor effecting the successful of equestrian planning in tourism based on selected journal. Based on high impact journals, the review was intended to gather a variety of factors that could influence the growth and the successful of equestrian tourism in a certain location. Furthermore, this review will identify the main factor to develop equestrian tourism and gathering diversity factor that will gain attention from equestrian stakeholder. Based on selected finding resources, this paper seeks to answer the research questions ''What is the most influential factor affecting equestrian planning in tourism?''. Due to the growing number of travelers who enjoy equestrian (Mukherjee, 2020) and the geographic characteristics that support the growth of this tourism product (Cernaianu & Sobry, 2019), William & Marlin (2020) highlight that equestrian tourism may become a significant factor increasing the allure of the state's tourism

destinations.

## METHODOLOGY

A systematic literature review has been applying to draw some conclusion on the field of equestrian planning collected from 50 published articles. In a systematic review, qualitative content analysis was employed to make sure the study was sufficiently reported and to make it simple to reproduce the findings. The main databases involve in this study including Scopus and Google Scholar. Scopus is a most suggested database since it makes it simple for scholars to obtain reliable research and access information that will guide choosing the related publication (Pranckute, 2021; Vera-Baceta, Thelwall, & Kousha, 2019; Oliveira, de Barros, Pereira, Gomes, & de Costa, 2018), where Google Scholar enables researcher to search scholarly articles and books, validate citations, and explore associated resources. To ensure a sufficiently coverage of the research field, researchers chose to apply PRISM screen methods towards target literature review, including the journal from the field of current issue, policy research, leisure and events, Ecotourism, sport and tourism, Scandinavian hospitality and tourism in Scandinavian, tourism planning & development, service management, trends in tourist behaviour (Table 1). The majority of scholarly research on equestrian tourism and tourist planning is published in these publications when they are all taken together. Therefore, the system literature review must follow the four essential steps of selecting a database, conducting an advanced keyword search, analysing the content, and discussing the analysis of the content.

Table 1. Articles collected from journal

| Articles collected from | Number of articles & Percentage (%) | The Name of Journal |
|---|---|---|
| Scopus | 36 (72%) | Scandinavian of Hospitality and Tourism, Tourism Planning & Development, Current issue in tourism, Policy Research in Tourism, Leisure and Events and Ecotourism. |
| Google Scholar | 9 (28%) | Service Management, Trends in Tourist Behaviour and Sport and Tourism. |

Content analysis has been utilized in this paper to analyse the content of planning documents, identify recurring topics, and understand the messages and effects of equestrian planning in tourism. All 50 selected journal articles have been categorised accordingly to collect data from keyword of "equestrian tourism" in the title, abstract or keywords in researcher targets journal. Furthermore, this research was conducted recently, utilized key words ("equestrian planning" "equestrian tourism", "horse-based tourism", "equestrian operators", "equestrian centre", "equestrian product", "equestrian event") to ensure a broader recording of the relevant literature. The present research contributes to the to-date knowledge available for the relevant topic (Streimikiene, Svagzdiene, Jasinskas, & Simanavicius, 2020) introducing use keywords on the investigated gap and growing research to more than one database to categories the finding. This study may address the issue raised by experts by using theoretical and methodological approaches. In total, the study identifies more than 50 studies on equestrian planning in tourism that were gathered from journal articles, books, and the Scopus database in order to gain valuable insights into equestrian planning in tourism.

## REVIEW FINDINGS

A total of 166 papers were identified by using PRISM to screen the articles, leaving 121 papers after duplicate removal. Researcher excluded 51 articles after reading the abstract because they only engage with general articles about the Equestrian. After screening the titles and abstracts of the articles, researcher removed 25 articles that did not meet the criteria set for this study. Lastly, we selected 50 studies for full-text reading, which met the eligibility criteria. Not only that, researcher also identified another 5 citations that met the criteria and included them in the systematic review (Figure 1)
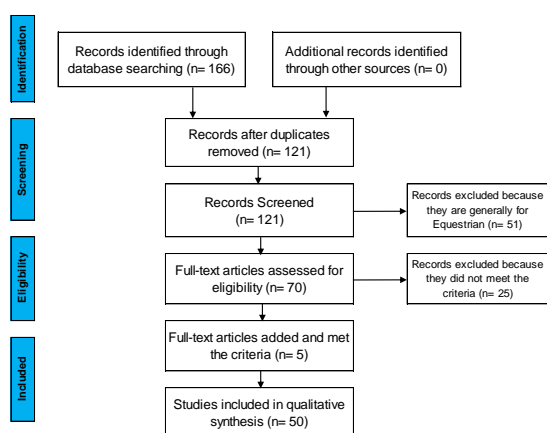


Figure 1. Flowchart of the article selection process.

In the two databases researched, out of 50 identified publications, 36 were identified using Scopus (72%) and 9 were identified using the Google Scholar (28%) (Table 1). Hence, most of the fields from 50 articles review covered by management area (24 articles, 48%). The tourism sector is the next most populous area (17 articles, 34%) and equine science has gained third-most reviews in papers (6 articles, 12%). According to research, the history review category has the fewest articles (3 articles, 6%). The majority of researchers believed that before any equestrian products are offered to tourists, management issues need to be resolved (Table 2).

Table 2. The common disciplines have been reviewed from the articles.

| Discipline | Number | Percentage |
| --- | --- | --- |

| | of | (%) |
| --- | --- | --- |
| | studies | |
| Management | 24 | 48 |
| Tourism | 17 | 34 |
| Equine science | 6 | 12 |
| History | 3 | 6 |

The factor affecting equestrian planning in tourism, as determined by the systematic literature study, were detailed and characterised in the order of popularity as follows (Table 3):

First, the *Factor affecting the development of equestrian tourism.* The development factor identifies from planning and implementation aspects. This factor type was found to be the most common in a total of 38 published articles (76%), 28 of them were related to tourism (56%) and 10 from the management sector (20%). There were 18 articles specifically on "equestrian development," 10 articles about "marketing," 6 articles about "environmental," and 4 articles about "operators" from the specific field of equestrian tourism. Second, the *Factor affecting the tourist*. It comes from the impact and influence of tourism on a particular destination. This is the next major category of elements mentioned in 25 articles (50%), 14 of which are in the tourism industry (28%), 8 are in the management industry (16%), and 3 are in the historical sector (6%). 15 articles discuss horse-related tourism attractions, six articles highlight the enjoyment and experience of horseback riding, and four articles discuss the unique reasons why people visit equestrian centres.

Third, the *Factor affecting the infrastructure of the horse trail.* The factor focuses on the design and construction of the trails that prioritize environmental and social sustainability. 15 publications (30%) identifying infrastructure factors; 8 articles (16%) in management; 6 articles (12%) in history; and 1 article (2%), in tourism. 11 articles address infrastructure for the growth of equestrian tourism and the horse industry in general. Then, 4 other articles

concentrate on major infrastructures, such as the transportation system, which includes highways, bridges, airports, harbours, and trails. Fourth, the *Factor affecting the involvement of the government* selected from support and policy aspects. It emerges in 10 publications analysed about it (20%), collaboration with the government has become a popular component shaping the tourism offering. 4 papers from equine science (8%), 6 articles from management (12%). The emphasis of seven articles included government engagement via the tourism act and company regulations. Three articles are devoted to the legitimacy of the government sector in supporting operators and equine centres. Fifth, the *Factor affecting the socio-culture of the community.* The socio-cultural characteristics of the community refer to the behaviour and interactions of individuals within the community. They are recognised 5 papers (10%) concentrate on sociocultural aspects. 2 articles (4%) are in the history field, and 3 (6%) are in the management field. Articles highlight psychological mechanisms and cultural effects on personality development in horse ownership, influenced by gender, religion, age, and socioeconomic status.

Table 3. The factor affecting equestrian planning in tourism.

| Factors | Number of studies | Percentage (%) |
| --- | --- | --- |
| Factor affecting the development of the equestrian tourism | 38 | 76 |
| Factor affecting the tourist | 25 | 50 |
| Factor affecting the infrastructure of the horse trail | 15 | 30 |
| Factor affecting the involvement of the government | 10 | 20 |
| Factor affecting the socio-culture of the community | 5 | 10 |

Based on the findings, the researcher identified management aspects as major influences in planning equestrian tourism. Research questions "'What is the most influence factor affecting equestrian planning in tourism?'' has been answer by referring to the data analysis. Development factors from planning and implementation aspects become major factors influencing the growth of equestrian tourism. This can be seen as management playing major roles in planning, organizing, leading, and controlling various aspects of equestrian tourism operations to achieve organizational goals and deliver exceptional experiences to tourists.

## DISCUSSION

In the previous 15 years, equestrian tourism is said to have developed and attained conceptual and methodological maturity (Sigurdardottir & Steinhorsson, 2018) which has led to various attempts to map and synthesize the current body of knowledge to be highlighted in the literature. The importance of systematic reviews has emerged as one of the primary methods for assessing the state of knowledge regarding equestrian tourism from the various sorts of analysis carried out by various academics. This would be a

pleasure to raise awareness among stakeholders in the equestrian tourism industry about how to improve equestrian planning in many aspects. Given the rise in equestrian tourist reviews over the past ten years, our study clearly demonstrates this tendency. Furthermore, this study can be a start-up plan for any equestrian industry to develop new equestrian programme within the community area.

However, this study also casts doubt on the methods and practices used by equestrian operators. More particular, the researchers considered the systematic review procedures and methods to evaluate papers by scholars. The majority of tourism-related literature, management, equine science, and history was examined in research using the literature review, methodology and the keyword "equestrian tourism." Researchers believe that there are very few articles related to the investigation area, but each item that has been examined provides advantages for researchers that may aid them in their concern for solutions to their research questions. The findings analysed revealed that different study groups from various discipline had distinct conceptualizations of the topic of equestrian planning in tourism.

## THE CONCLUSION OF THE REVIEW

The reviewed articles were eventually published in numerous journals across a wide range of disciplines. Most research on equestrian tourism has been done from the viewpoints of sport, events, welfare, and development. In publications relevant to equestrian tourism planning, there was a limited paper study by the researcher across the region. The primary reason this topic has been studied is that the researcher selects publications that are more closely related to the main focus, which is equestrian planning in tourism, in order to achieve the desired results. Equestrian professionals could benefit from this study to support their attempts to develop sustainable and effective rules. Additionally, by carefully using the principles as the primary source for future equine tourist growth, this study may be able to assist tourism organizations.

## METHODOLOGY EVALUATION & FUTURE RESEARCH

For this study, a systematic literature review was done to examine at 50 research publications that were found in the Scopus and Google Scholar databases. The decision to select keywords on pertinent papers from high impact journals has produced satisfying results and intriguing points to be added. By introducing the usage of keywords on the study and extending the research to several sources, the current research adds to the most current understanding of the topic and field. After taking into consideration the constraints of systematic literature reviews identified via the analysis of the current study, the researcher recommends that there is still a dire need for consistency of systematic studies in the areas of equestrian tourism and tourism planning. Given that there are becoming more research on the topic of equestrian tourism, researchers also contend that training is important for academics to understand the development of techniques supporting the study of equestrian tourism. This study points out areas for future research that will benefit from greater equestrian tourism and tourism planning knowledge as well as knowledge gaps in the existing literature.

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# THE EMERGING OF RAIL TOURISM AS SUSTAINABLE TOURISM IN MALAYSIA

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## ABSTRACT

Rail tourism encompasses various forms of tourism centred around train travel. Rail trails have been characterized as multi-use trails utilized for transportation and recreation, by locals or visitors. Rail tourism is the proponent of slow tourism, which advocate a relaxed and responsible approach to travel. Even though rail tourism is emerging among Special Interest Tourists (SITS) in Malaysia, it was still difficult to determine the attributes that strengthen the attractiveness of the railway. Therefore, this paper aims to determine the attributes of rail tourism attractiveness that contribute to the emergence of rail tourism as sustainable tourism in Malaysia among SITS. SITS can be defined as a specialized style of touristy that focus on one's interests. A survey on experiences in rail tourism and satisfaction on the rail tourism dimension was conducted for this paper. This also involved an interview with the stakeholder to clarify and explain the features of rail tourism based on a survey and literature review. As for that, it's pointed out that the attributes that strengthen the attractiveness of the railway based on SITS perception were: (i) tourism attraction; (ii) amenities and (iii) activities along the journey. It's also mentioned that the emergence of rail tourism has amenities increased the economy, especially for sub-urban areas. The involvement of the local community in the development of rail tourism can be identified as sustainable tourism. The rail industry must seize the opportunity to impose that trains are the future's sustainable source of transportation.

*Keywords:* **Rail Tourism, Rail Tourism Attractiveness, Special Interest Tourist, Sustainable Tourism**

## INTRODUCTION

Rail tourism, encompassing various forms of tourism centered around train travel, is gaining popularity as a sustainable and responsible approach to travel. Rail tourism in Malaysia has been gaining momentum as a sustainable and environmentally friendly alternative to traditional forms of tourism [1]. Based on previous study, it has been identified that there has been significant development of numerous rail trails in Malaysia [2]. However, only a limited number of these trails have undergone comprehensive academic research, presenting a challenge in identifying which ones possess the characteristics that could

make them attractive tourism destinations [1,3,4,5]. The railway lines in Peninsular Malaysia have a rich history, dating back over a century to the colonial era. Presently, these railway lines primarily serve as intercity transportation, linking larger towns with rural areas in Peninsular Malaysia. Traditionally, locals have mainly relied on cars and buses for traveling to rural towns in this region. Intercity trains are primarily used by residents returning to their hometowns, rather than for recreational or vacation purposes. Nevertheless, the experience of traveling on these intercity trains holds the potential to become an integral aspect of the overall tourism experience [3]. The journey offers a unique opportunity to witness picturesque views of rural towns that are not easily accessible through other modes of transportation in Peninsular Malaysia, contributing to the charm of sustainable tourism.

To understand the key attributes that contribute to the emergence of rail tourism as sustainable tourism among special interest tourists in Malaysia, several factors need to be considered [6,7]. Thus, this paper aims to determine the attributes of rail tourism attractiveness that contribute to its emerging status as a sustainable tourism option in Malaysia, specifically among Special Interest Tourists (SITS) who are characterized by their specialized interests. The study involved a survey on rail tourism experiences and satisfaction with rail tourism dimensions, and interviews with stakeholders to clarify and explain the features of rail tourism based on survey data and literature review.

## LITERATURE REVIEW

This study will provide an exhaustive literature review on the underpinning theory and the concept and context of values of rail tourism, sustainable tourism and rail tourism as sustainable tourism.

### 2.1. Rail tourism

Rail tourism can be broadly classified in two ways: as a means of transportation used by tourists to reach their destinations [6], or as a standalone tourist product itself [8]. In recent years, there has been a noticeable surge in the pursuit of enhancing travel experiences, which includes catering to nostalgic sentiments, a desire for historical connections, and the provision of value-added services both on and off-board trains. As a result, a new category of railway journeys has emerged, marketed and enjoyed as tourism products in their own right [9]. Even the rail tourism has been started as early as 1999, the rail tourism in Malaysia has emerged recently [9].

Railways and tourism have been closely intertwined since their early existence. Rail tourism falls under the domain of special interest tourism (SIT), which represents a niche market with a particular focus on sustainable tourism practices, encompassing rail travel as a sustainable transportation option. Scholars, [3,10,11,12,13,14,15,16] have extensively studied that this emerging trend in tourism is a response to the adverse impacts of mass tourism on the environment, prompting a growing interest in alternative and sustainable forms of travel and experiences. In recent times, rail tourism has attracted scholarly interest as a type of slow and sustainable tourism with reduced environmental effects [8,17].
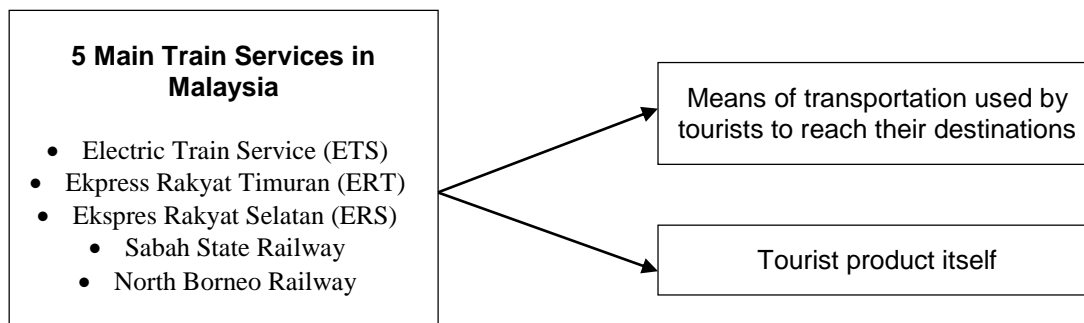
**Figure 1.** Function of Railway in Malaysia

## 2.2 Sustainable Tourism

Sustainable tourism encompasses more than just the preservation of nature or socially responsible business practices. According to Streimikiene et al., it is essential to emphasize that the theoretical concept of sustainable tourism includes dimensions of economic, social, and environmental protection [18]. However, it is observed that social involvement is an aspect that often receives less attention in this context. Sustainable tourism can be described as a development approach that integrates tourism, resources, and the human living environment, ensuring harmonious coordination between tourism and the social economy, resources, and the environment [19]. The core principle of sustainable tourism is to prioritize the long-term and coordinated development of tourism activities in alignment with societal needs, economic considerations, resource management, and environmental preservation. Sustainable tourism refers to a form of tourism that takes into account environmental, social, and economic considerations to ensure long-term benefits for both the destination and the host community [20]. In this paper, rail tourism reveals several characteristics that align with the principles of sustainable tourism such as environmental benefits, economic opportunities, and also social engagement. Rail tourism is generally regarded as a more environmentally friendly mode of transportation compared to air or road travel [21]. Trains produce fewer greenhouse gas emissions per passenger mile and consume less

energy. By promoting rail tourism in Malaysia, it can reduce the carbon footprint associated with transportation and contribute to the

overall reduction of pollution. Rail tourism often takes advantage of existing rail infrastructure, utilizing historical or scenic routes. By utilizing existing rail lines, rail tourism minimizes the need for new construction and reduces the negative impacts on natural landscapes. It also provides opportunities for the preservation and promotion of cultural heritage by connecting tourists with historic towns, landmarks, and cultural attractions.

## 2.3 Rail Tourism as Part of Sustainable Tourism

Rail tourism has the potential to generate economic benefits for local communities, particularly in rural or suburban areas [22]. It can stimulate the growth of small businesses, create employment opportunities, and contribute to the diversification of local economies. According to Bhati et al., rail tourism also encourages tourists to explore lesser-known destinations, distributing the benefits of tourism more evenly and reducing overreliance on popular tourist hotspots [23]. Socio-cultural is one of the sustainable criteria for rail tourism. In this study, it shows that rail tourism often involves collaboration with local communities, including the provision of tourism services, accommodation, and dining options. One of the proposed activities suggested was to collaborate with Malaysia Homestay Experience Program (MHEP) [3]. The MHEP has huge potential and could benefit not only local communities but also all stakeholders involved directly or indirectly [24]. Engaging the local community in the development and operation of rail tourism can lead to a sense of ownership and empowerment. It provides opportunities for locals to showcase their culture, traditions, and

hospitality, fostering a more authentic and immersive experience for tourists.

Railway tourism has the lowest ecological impacts among other types of tourism in natural and rural areas, and efforts from researchers and authorities in this field could be helpful in protecting the environment, as demonstrated by the case study of Tehran-Mazandaran Old Railway [25].

Railway tourism is a sustainable solution meant to stimulate interest in learning about local history and culture and can at the same time contribute to the fulfilment of knowledge of the motivations that drive tourist demand [26]. Rail tourism is increasingly recognized as a significant component of sustainable tourism, offering potential solutions to the environmental, socio-cultural, and economic challenges faced by conventional mass tourism. Several studies have explored the role of rail tourism in fostering sustainable tourism practices, and their findings highlight the following key attributes.

### 2.3.1    Accessibility and connectivity.

The first attributes of rail tourism as sustainable tourism in Malaysia are accessibility and connectivity [7]. Special interest tourists (SITs) seek convenience and easy accessibility to destinations. The attractiveness of rail tourism lies in its ability to connect major tourist destinations across the country efficiently. An extensive and well-connected rail network that covers popular attractions, national parks, and cultural sites enhances the appeal of rail tourism, allowing tourists to explore multiple locations with minimal environmental impact.

### 2.3.2    Eco-friendly transportation.

The second attribute is eco-friendly transportation [21]. According to Givoni & Banister rail transport is possibly 'greener' and environmental-friendly as it is proven that it consumes lesser energy than the other means of transport utilized for long-distance travel [21]. Tourists who chose to travel slowly by utilizing rail would automatically participate in low carbon travelling whether they realize it or not. Sustainability is a paramount concern for SIT who are conscious of their carbon footprint. Rail tourism is perceived as a greener alternative to other modes of transportation, such as flights or private vehicles, due to its lower carbon emissions. According to a study conducted in 2018, tourism was found to account for 8% of the global carbon

dioxide emissions [27]. Reviewing the implementation of eco-friendly practices, energy-efficient technologies, and waste reduction strategies within the rail tourism sector can reveal its contributions to sustainable tourism.

### 2.3.3    Cultural immersion and experience.

Rail tourism provides a unique opportunity for special interest tourists to immerse themselves in the local culture and heritage [2]. The design of rail journeys to showcase regional traditions, cuisines, and arts can significantly enhance the overall attractiveness of rail tourism. Authentic experiences and interactions with local communities along the railway routes contribute to a sustainable tourism approach, as it promotes cultural preservation and community engagement.

### 2.3.4    Preservation of natural landscape.

Another attribute is the preservation of natural landscapes. The scenic beauty of Malaysia's landscapes is a major draw for special interest tourists. Rail tourism has the potential to offer panoramic views of nature and wildlife without causing harm to sensitive ecosystems [28]. Assessing how rail tourism incorporates conservation efforts and protects natural areas during its operations can shed light on its role in sustainable tourism.

### 2.3.5    Responsible tourism practice.

In addition, responsible tourism practices are also one of the attributes of rail tourism that contributing to sustainable tourism in Malaysia among SIT [29]. SIT is increasingly interested in supporting responsible tourism initiatives. Reviewing the commitment of rail tourism operators to responsible practices, such as waste management, water conservation, and support for local economies, helps understand its positive impact on sustainability.

### 2.3.6    Inclusivity and amenities.

Rail tourism should strive to be inclusive and provide the amenities to all, including differently-abled individuals [7]. An analysis of efforts made to accommodate the needs of diverse tourists and promote accessible travel can highlight the role of rail tourism in supporting social sustainability.

### 2.3.7    Collaboration with local stakeholders.

The last attribute is a collaboration with local stakeholders. Engaging and involving local communities in the development and management

of rail tourism is vital for its sustainability [30]. Evaluating the extent of collaboration between rail tourism operators, local businesses, and community organizations can reveal the positive contributions rail tourism makes to community empowerment and economic development.

## 2.4 Rail Tourism in Malaysia (Electric Train Services –ETS)

The KTM ETS, also known as the Electric Train Service, is an inter-city rail passenger service operated by Keretapi Tanah Melayu (KTM) using electric multiple-unit (EMU) trains. It is the second electric train service offered by the Malaysian railway company, following the KTM Komuter service, and the second inter-city rail service after KTM Intercity. The ETS is known for being the fastest metre-gauge train service in Malaysia, running along the electrified and double-tracked stretch of the West Coast Line between Gemas and Padang Besar in Peninsular Malaysia, which was previously served by KTM Intercity. Currently, the rail service is operated by KTM Intercity Division, having been previously managed by ETS Sendirian Berhad, a wholly-owned subsidiary of Keretapi Tanah Melayu Berhad.



**Figure 2.** Peninsular Malaysia Railway Route Map

In line with the development of these train routes and the flourishing tourism activities, Tourism Malaysia introduced three main railway tourism packages in 2010 as part of its efforts to promote rural tourism destinations. These packages are known as "Day-Trip by Rail," "North and East-bound Homestay by Rail," and "Resplendence Resort by Rail." The Ministry of Tourism, Culture, and Arts (MOTAC) successfully launched the "Experience Malaysia Homestay Packages by Rail," featuring 42 all-inclusive homestay packages from 21 homestays licensed by the Ministry of Tourism in 2015.
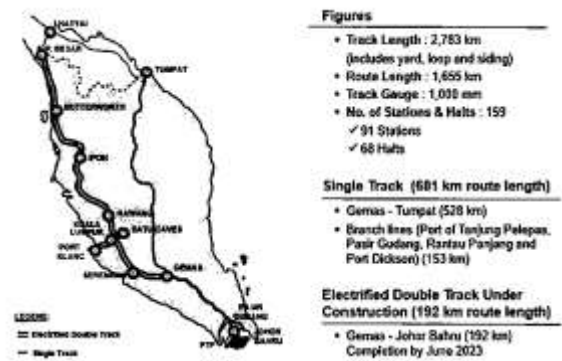


**Figure 3.** Track of railway in Peninsular Malaysia

While these packages are heavily marketed to Singaporeans as the rail travel starts at Tanjong Pagar railroad station, Singapore, there has been growing interest from tourists of other nationalities, including European and other Asian travelers, who seek to experience the authentic rural charm of peninsular Malaysia. Furthermore, the findings of scholars indicate that the tourism authorities gain valuable insights into the perceptions of tourists traveling by train to these rural destinations [3]. These insights are essential for the continuous improvement and enhancement of the overall rail-homestay experiences provided to travelers.
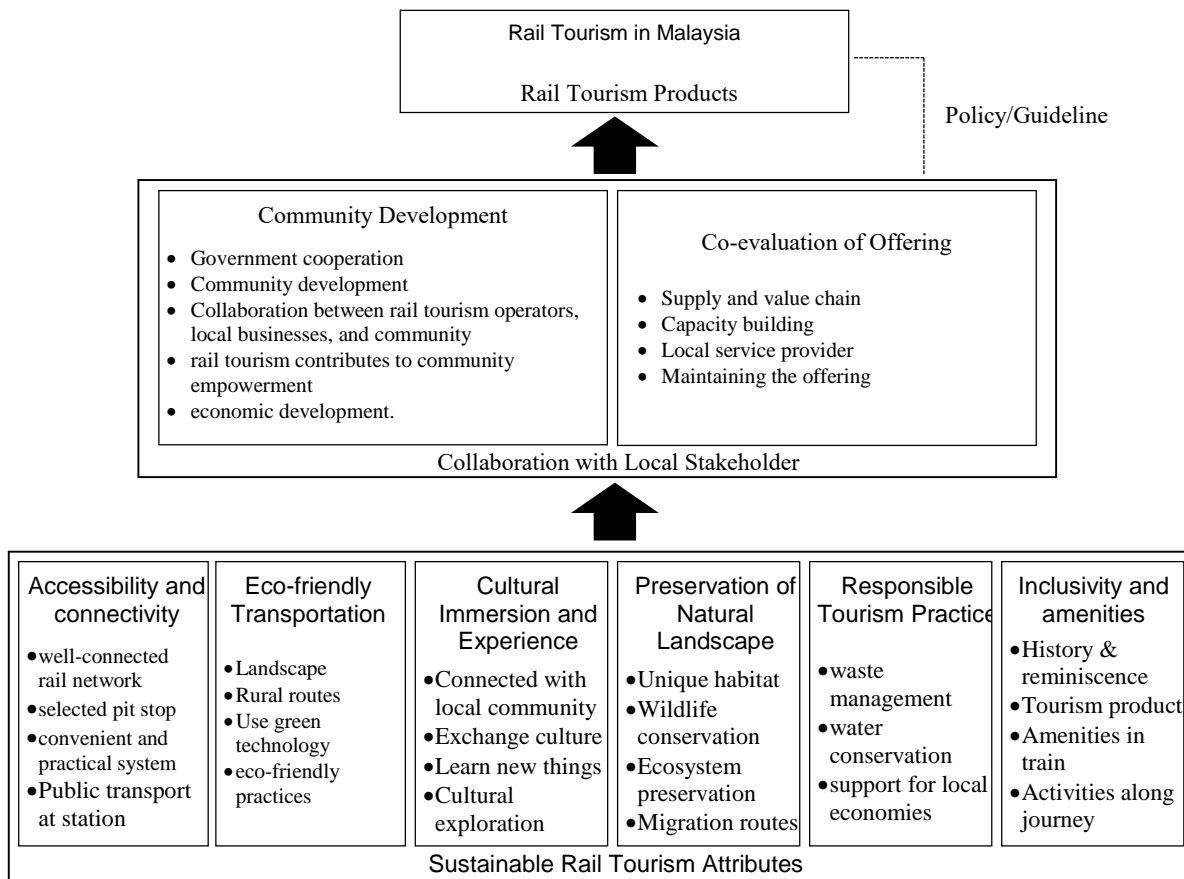
**Figure 4.** Rail-Centric Sustainable Tourism Product

Based on the review of the literature, this study able to proposed a framework that schematically models the structural relationship between the sustainable rail tourism attributes, partner and stakeholder and development of rail tourism, as shown in figure 4.

## 3 Methodology

This study utilizes a quantitative research design to investigate the attributes of rail tourism attractiveness that contribute to the emergence of rail tourism as sustainable tourism in Malaysia among SITS. The study employs purposive sampling to deliberately select participants who meet specific criteria, ensuring an accurate representation of the special interest tourist group.

Before administering the final questionnaire, a pilot study is conducted to improve its effectiveness. A set of questionnaires has been distributed to the 25 tourists on the train journey from KL Central to Ipoh using ETS. The process of cleaning, transforming, and modelling data to discover useful information for making business decisions is called data analysis. The goal of data analysis is to find relevant information in the data and make decisions based on that information.

In this study, Statistical Package for Social Sciences (SPSS) Version 20 has been utilized for the data screening process and for the assessment of the respondents' descriptive analysis and measurement purposes.

This research tested scale reliability with Cronbach's Alpha, which is a measure of consistency within a scale in an instrument [31,32]. In this study, the reliability test was performed for each attribute. The values of Cronbach's alpha for the impact of all respondents are greater than 0.70 (Table 1) which means well above the threshold of 0.50 [33].

Table 1. **Validity and reliability of constructs**

| Sustainable Rail Tourism Attributes | Factor Loading | Cronbach's Alpha |
|---|---|---|
| **Accessibility and connectivity** | 0.779 | 0.709 |
| **Eco-friendly transportation** | 0.751 | 0.832 |
| **Cultural immersion and experience** | 0.875 | 0.781 |
| **Preservation of natural landscape** | 0.777 | 0.844 |
| **Responsible tourism practice** | 0.814 | 0.738 |
| **Inclusivity and amenities** | 0.697 | 0.719 |
| **Collaboration with local stakeholders** | 0.692 | 0.758 |

After the analysis of the pilot test, there are no suggestions or need for changes to the questionnaire and it can be distributed to the respondents. Data was collected through a structured questionnaire, designed based on literature review and expert consultation and has been distributed to the respondents who are the members of the group "*Jom Naik Keretapi*".

The questionnaire consisted of two parts. The first part gathered data on the profile of the respondents in terms of gender, age, nationality, employment status and frequency of using the train to travel. The second part of the questionnaire determined the level of consideration in deciding to sustainable rail tourism attributes, such as (i) accessibility and connectivity; (ii) ecofriendly transportation; (iii) cultural immersion and experience; (iv) preservation of natural landscape; (v) responsible tourism practice; (vi) inclusivity and amenities; and (vii) collaboration with local stakeholder. Respondents could respond from 1 (Not Important) to 5 (Very Important) (See Table 2). The mean and mean ranges (shown in Table 2) were utilized to determine the level of consideration in deciding on sustainable rail tourism attributes.

Table 2. **The 5 point scale, mean range and verbal interpretation**

| Weight/Scale | Mean Range | Verbal Interpretation (VI) |
|---|---|---|
| 5 | 4.51-5.00 | Very Important |
| 4 | 3.51-4.50 | Important |
| 3 | 2.51-3.50 | Fairly Important |
| 2 | 1.51-2.50 | Slightly Important |
| 1 | 1.00-1.51 | Not Important |

The 372 data were collected and been analysed using SPSS to identify the weighted average for ranking purposes.

## 4. Findings

### 4.1 Respondent Profile

Based on the table, the proportion of male respondents (52.42%) more than and female respondents (47.58%). The dominant age range was 25-44 years (62.10%), followed by 45-64 (28.23%). The majority of respondents (58.06%) are employed. Malaysian accounted for 96.77% of the total respondents, followed by non-Malaysians counted at 3.23%. The frequency of using trains for tourism travel routes with the highest percentage was at least once a year (41.94%).

Table 3: Socio-demographic profile

| Variable | Categories | N=372 | Percentage (%) |
|---|---|---|---|
| Gender | Male | 195 | 52.42 |
| | Female | 177 | 47.58 |
| Age | 19 years old and below | 0 | 0.00 |
| | 20 - 24 years old | 21 | 5.65 |
| | 25 - 44 years old | 231 | 62.10 |
| | 45 - 64 years old | 105 | 28.23 |
| | 65 years old and above | 15 | 4.03 |
| Nationality | Malaysian | 360 | 96.77 |
| | Non-Malaysian | 12 | 3.23 |
| Employment Status | Employed | 216 | 58.06 |
| | Self-employed | 36 | 9.68 |
| | Unemployed | 16 | 4.30 |
| | Retired | 28 | 7.53 |
| | Student | 76 | 20.43 |
| Frequency of using the train to travel before | Once a month | 64 | 17.2 |
| | More than once a month | 52 | 13.98 |
| | At least once a year | 156 | 41.94 |
| | At least once in every two years | 100 | 26.88 |

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| | At least once in every two years | 100 | 26.88 |

The findings expose the important attributes that contribute to the emergence of rail tourism as sustainable tourism in Malaysia are accessibility and connectivity, environmental friendliness, cultural immersion and experiences, preservation of natural landscapes, responsible tourism practices, inclusivity and accessibility and also collaboration with stakeholders. The result of the for each attribute will be shown.

**Table 4.** Mean respondent's perception of the importance of accessibility and connectivity (AN) in sustainable rail tourism

| Elements (AN) | Total (N) | Not Important F (%) | Slightly Important F (%) | Fairly Important F (%) | Important F (%) | Very Important F (%) | Mean | VI |
|---|---|---|---|---|---|---|---|---|
| Well-connected rail network | 372 | 0 (0) | 25 (6.72) | 36 (9.68) | 185 (49.73) | 126 (33.87) | 4.10 | Important |
| Selected pit stop | 372 | 7 (1.88) | 37 (9.95) | 51 (13.70) | 87 (23.39) | 190 (51.08) | 4.12 | Important |
| Convenient and practical system by the provider | 372 | 0 (0) | 13 (3.50) | 10 (2.67) | 105 (28.23) | 244 (65.6) | 4.56 | Very Important |
| Public transport at the station | 372 | 35 (9.40) | 12 (3.23) | 135 (36.30) | 85 (22.85) | 105 (28.22) | 3.57 | Important |
| | | | | | **Overall Mean Value** | | **4.09** | **Important** |

For AN attributes, a convenient and practical system by the provider was a very important criterion selected by respondents. For overall value, it was concluded as important.

**Table 5.** Mean respondent's perception of the importance of eco-friendly ecosystem (ET) in sustainable rail tourism

| Elements (ET) | Total (N) | Frequency Analysis | | | | | Mean | VI |
|---|---|---|---|---|---|---|---|---|
| | | Not Important F (%) | Slightly Important F (%) | Fairly Important F (%) | Important F (%) | Very Important F (%) | | |
| Landscape | 372 | 0 (0) | 0 (0) | 23 (6.18) | 154 (41.4) | 195 (52.42) | 4.46 | Important |
| Rural routes | 372 | 2 (0.54) | 13 (3.49) | 43 (11.56) | 134 (36.02) | 180 (48.39) | 4.28 | Important |
| Using green technology | 372 | 15 (4.03) | 31 (8.34) | 102 (27.42) | 96 (25.8) | 128 (34.41) | 3.78 | Important |
| Ecofriendly practice | 372 | 21 (5.65) | 19 (5.11) | 49 (13.17) | 109 (29.30) | 174 (46.77) | 4.06 | Important |
| | | | | | Overall Mean Value | | **4.15** | **Important** |

For ET attributes, landscape was a very important criterion selected by respondents. For overall value, it was concluded as important.

**Table 6.** Mean respondent's perception of the importance of cultural immersion and experience (CIE) in sustainable rail tourism

| Elements (CIE) | Total (N) | Frequency Analysis | | | | | Mean | VI |
|---|---|---|---|---|---|---|---|---|
| | | Not Important F (%) | Slightly Important F (%) | Fairly Important F (%) | Important F (%) | Very Important F (%) | | |
| Connected with local communities | 372 | 0 (0) | 15 (4.03) | 37 (9.95) | 184 (49.46) | 136 (36.56) | 4.19 | Important |
| Exchange culture | 372 | 3 (0.81) | 16 (4.30) | 85 (22.85) | 101 (27.15) | 167 (44.89) | 4.11 | Important |
| Learn new things | 372 | 51 (13.71) | 74 (19.89) | 41 (11.02) | 84 (22.58) | 122 (32.80) | 3.41 | Fairly Important |
| Cultural exploration | 372 | 0 (0) | 14 (3.76) | 89 (23.92) | 119 (31.99) | 150 (40.32) | 4.09 | Important |
| | | | | | Overall Mean Value | | **3.95** | **Important** |

For CIE attributes, connected with the local community was an important criterion selected by respondents. For overall value, it was concluded as important.

**Table 7.** Mean respondent's perception of the importance of preservation f natural landscape (PNL) in sustainable rail tourism

| Elements (PNL) | Total (N) | Frequency Analysis | | | | | Mean | VI |
|---|---|---|---|---|---|---|---|---|
| | | Not Important F (%) | Slightly Important F (%) | Fairly Important F (%) | Important F (%) | Very Important F (%) | | |
| Unique habitat | 372 | 13 (3.49) | 21 (5.65) | 101 (27.15) | 66 (17.74) | 171 (45.97) | 3.97 | Important |
| Wildlife conservation | 372 | 15 (4.03) | 31 (8.33) | 76 (20.43) | 111 (29.84) | 139 (37.37) | 3.88 | Important |
| Ecosystem preservation | 372 | 36 (9.68) | 27 (7.26) | 75 (20.16) | 103 (27.69) | 131 (35.22) | 3.71 | Important |
| Migration routes | 372 | 29 (7.80) | 19 (5.11) | 68 (18.28) | 113 (30.38) | 143 (38.44) | 3.87 | Important |
| | | | | | **Overall Mean Value** | | **3.86** | **Important** |

For PNL attributes, unique habitat was an important criterion selected by respondents. For overall value, it was concluded as important.

**Table 8.** Mean respondent's perception of the importance of responsible tourism practice (RTP) in sustainable rail tourism

| Elements (RTP) | Total (N) | Frequency Analysis | | | | | Mean | VI |
|---|---|---|---|---|---|---|---|---|
| | | Not Important F (%) | Slightly Important F (%) | Fairly Important F (%) | Important F (%) | Very Important F (%) | | |
| Waste management | 372 | 3 (0.81) | 11 (2.96) | 47 (12.63) | 106 (28.49) | 205 (55.11) | 4.34 | Important |
| Water conservation | 372 | 21 (5.65) | 19 (5.11) | 98 (26.34) | 136 (36.56) | 98 (26.34) | 3.73 | Important |
| Support local communities | 372 | 0 (0) | 71 (19.09) | 63 (16.94) | 95 (25.54) | 143 (38.44) | 3.83 | Important |
| | | | | | **Overall Mean Value** | | **3.97** | **Important** |

For RTP attributes, waste management was an important criterion selected by respondents. For overall value, it was concluded as important.

**Table 9.** Mean respondent's perception of the importance of inclusivity and amenities (IA) in sustainable rail tourism

| Elements (IA) | Total (N) | Frequency Analysis | | | | | Mean | VI |
|---|---|---|---|---|---|---|---|---|
| | | Not Important F (%) | Slightly Important F (%) | Fairly Important F (%) | Important F (%) | Very Important F (%) | | |
| History and reminiscence | 372 | 4 (1.08) | 9 (2.42) | 42 (11.29) | 146 (39.25) | 171 (45.97) | 4.27 | Important |
| Tourism product | 372 | 2 (0.54) | 12 (3.23) | 48 (12.90) | 192 (51.61) | 118 (31.72) | 4.11 | Important |
| Amenities in train | 372 | 4 (1.08) | 16 (4.30) | 47 (12.63) | 108 (29.03) | 197 (52.96) | 4.28 | Important |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Activities along the journey | 372 | 12 (3.23) | 39 (10.48) | 63 (16.94) | 168 (45.16) | 90 (24.19) | 3.77 | Important |
| | | | | | **Overall Mean Value** | | **4.11** | **Important** |

For IA attributes, amenities in train was an important criterion selected by respondents. For overall value, it was concluded as important.

**Table 10.** Mean respondent's perception of the importance of collaboration with stakeholder (CS) in sustainable rail tourism

| Elements (CS) | Total (N) | Frequency Analysis | | | | | Mean | VI |
|---|---|---|---|---|---|---|---|---|
| | | Not Important F (%) | Slightly Important F (%) | Fairly Important F (%) | Important F (%) | Very Important F (%) | | |
| Government cooperation | 372 | 9 (2.42) | 11 (2.96) | 65 (17.47) | 174 (46.77) | 113 (30.38) | 4.00 | Important |
| Community development | 372 | 0 (0) | 29 (7.80) | 53 (14.25) | 128 (34.41) | 162 (43.55) | 4.14 | Important |
| Collaboration between rail tourism operators, local empowerment and community | 372 | 0 (0) | 21 (5.65) | 51 (13.71) | 112 (30.11) | 188 (50.54) | 4.26 | Important |
| Rail tourism contribution to community empowerment | 372 | 0 (0) | 29 (7.80) | 48 (12.90) | 136 (36.56) | 159 (42.74) | 4.14 | Important |
| Economic development | 372 | 15 (4.03) | 29 (7.80) | 67 (18.01) | 161 (43.28) | 100 (26.88) | 3.81 | Important |
| | | | | | **Overall Mean Value** | | **4.07** | **Important** |

For CS attributes, collaboration between rail tourism operators, local empowerment and community was an important criterion selected by respondents. For overall value, it was concluded as important.

This research provides valuable insights into the attributes that enhance the attractiveness of rail tourism in Malaysia, offering guidance for stakeholders involved in tourism planning and development. By understanding and leveraging these attributes, policymakers, destination managers, and the rail industry can foster the growth of rail tourism, contributing to the sustainable development of the tourism sector in Malaysia. Furthermore, it is highlighted that the emerging trend of rail tourism has contributed to economic growth, particularly in suburban areas. The involvement of the local community in the development of rail tourism has been identified as a crucial factor in achieving sustainable tourism practices.

**Table 11.** Sustainable rail tourism attributes

| Sustainable Rail Tourism Attributes | SITs Respondents (N=372) | |
| --- | --- | --- |
| | **Mean** | **Verbal Interpretation** |
| Accessibility and connectivity | 4.09 | Important |
| Eco-friendly transportation | 4.15 | Important |
| Cultural immersion and experience | 3.95 | Important |
| Preservation of natural landscape | 3.86 | Important |
| Responsible tourism practice | 3.97 | Important |
| Inclusivity and amenities | 4.11 | Important |
| Collaboration with local stakeholders | 4.07 | Important |

Additionally, this paper emphasizes the need for the rail industry to recognize and seize the opportunity to position trains as a sustainable mode of transportation for the future.

## 5    Conclusion

In conclusion, the increasing popularity of rail tourism among SIT in Malaysia reflects a growing interest in sustainable travel options. The attributes contributing to the attractiveness of rail tourism in this context encompass a range of eco-friendly and culturally immersive elements. These include accessible and well-connected transportation options, environmentally friendly, responsible tourism practices, collaboration with local stakeholders, and a commitment to inclusivity.

Rail tourism's eco-friendly transportation stands out as a key factor, offering tourists a low-carbon alternative to traditional modes of travel. The appeal of scenic landscapes observed from train windows adds to the allure, providing travellers with a unique and environmentally conscious way to experience Malaysia's natural beauty. Moreover, rail tourism's emphasis on cultural immersion aligns with the values of special interest tourists seeking authentic and meaningful travel experiences. By engaging with local communities along the railway routes, tourists can foster cross-cultural understanding and contribute positively to the socio-economic development of these regions.

The accessibility and connectivity of rail networks further enhance the appeal of this sustainable travel option. Efficient and convenient transportation options make it easier for special interest tourists to explore diverse destinations, supporting the growth of tourism in less-visited areas and dispersing its economic benefits more evenly.

Additionally, rail tourism's commitment to sustainable infrastructure and practices demonstrates a conscious effort to minimize the environmental impact of travel. By adopting responsible tourism practices and investing in eco-friendly initiatives, rail tourism aligns with the evolving preferences of special interest tourists seeking eco-conscious choices. Furthermore, the collaboration with local stakeholders showcases a commitment to social responsibility and community engagement. Empowering local communities to participate in and benefit from tourism activities fosters a sense of ownership and pride in preserving their cultural heritage and natural surroundings. Lastly, rail tourism's inclusivity appeals to a wide range of special interest tourists, accommodating various travel preferences and needs. The inclusive nature of this mode of travel allows for a diverse and enriching experience, ensuring that tourists of different backgrounds and abilities can participate in and enjoy the journey.

The rise of sustainable tourism practices has significantly influenced the preferences of SIT in Malaysia, leading them to seek eco-friendly alternatives for their travel experiences. Embracing and promoting the key attributes that make rail tourism an appealing and sustainable option will play a crucial role in sustaining its growth as a preferred choice for special interest tourists in Malaysia. By continuing to foster eco-friendly and culturally immersive experiences, rail tourism can make a significant contribution to the conservation of the environment and the preservation of Malaysia's unique cultural heritage. As scholars, we encourage further research and collaboration among stakeholders to enhance rail tourism's sustainability and ensure its continued appeal to special interest tourists seeking meaningful and eco-conscious travel experiences in Malaysia and beyond.

In conclusion, while rail tourism exhibits characteristics that align with sustainable tourism principles, its sustainability ultimately depends on effective planning, management, and the consideration of environmental, social, and economic factors. With appropriate measures in place, rail tourism has the potential to contribute positively to sustainable tourism development. According to Khan et al, the expansion of rail

tourism presents a cost-efficient approach to diversifying a nation's tourism portfolio, attracting high-quality and niche tourist segments, and fostering sustainable tourism development [34].

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# CHALLENGES AND POTENTIAL SOLUTIONS IN IMPLEMENTING STRATA SUBDIVISION TERMINATION FOR URBAN REDEVELOPMENT: A REVIEW

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## ABSTRACT

This article examines the challenges and potential solutions associated with the implementation of strata subdivision termination, which involves dissolving shared ownership in a multi-title development to facilitate land redevelopment. Amendments to strata legislations in several countries have introduced unintended negative impacts, including the displacement of minorities and vulnerable populations, unfair voting determinants and sales allocation, and implications for future city planning. This study aims to explore the challenges and potential solutions to mitigate these adverse effects on individuals and communities. Using the narrative literature review, insights are drawn from previous literature that discusses the implementation of termination processes. The findings highlight the importance of considering legislative aspects, such as the age of the building and voting determinants, implementation aspects including free advocacy and support groups, and policy aspects such as affordable housing and government involvement in decision-making for city planning with strata termination. The main aim of this article is to enhance awareness of the challenges involved in strata subdivision termination and provide valuable guidance to policymakers and stakeholders. By offering proposed solutions, the article seeks to facilitate effective navigation of the termination process and foster informed decision-making among all parties involved.

*Keywords: strata subdivision termination, en-bloc sale, strata renewal, urban redevelopment, multi-owned buildings, strata title.*

## INTRODUCTION

The New Urban Agenda aims to create sustainable and inclusive cities for future generations. As part of this goal, urban redevelopment is a key effort to combat urban decay, minimize carbon footprints, and mitigate the risks of urban sprawl (Robert & Sykes, 2008). Compared to the huge population it has to hold, the relative size of the urban area demands a good urban development effort and land-use planning. Consequently, stratified buildings such as apartment complexes, multi-owned

buildings, and similar structures that comprise multiple stories and parcels for residential or commercial purposes have become increasingly prevalent in cities worldwide. This approach has demonstrated its relevance and economic viability in addressing land scarcity and optimizing land utilization (Watt, 2017). The city has its life cycle, starting with exceptional growth and ending with unavoidable decay (Gotham, 2001a). Urban decay is detrimental to a city because it could change its social fabric and economic structure, increasing the crime rate, physical dilapidation, and social polarization. Just like the city, the building also has its own life cycle (Easthope et al., 2014). There are a number of ways to decrease the negative effects of urban and building degradation, including terminating the strata buildings to redevelop new ones (Randolph, 2006a).

Notwithstanding the need and significance of strata termination, there are imminent challenges that arise in its implementation. This involves the complex procedure of terminating the strata subdivision of multi-owned properties in order to facilitate their redevelopment (Zakiah & Khadijah, 2016). Apart from that, challenges are also due to conflicting individual interests, differing perspectives, financial considerations, and the potential displacement of marginalized and vulnerable populations (Crommelin et al., 2020; Easthope et al., 2013a). Exploring the intricacies of strata renewal, various crucial elements come into play, including obtaining consent from parcel owners, ensuring fair compensation, and establishing a platform for effective communication. Several countries including Singapore and Australia have revised their laws to allow for less-than-unanimous or supermajority consent (Crommelin et al., 2020; E. S. Ti, 2022). However, these countries still face major challenges in ensuring the successful implementation of the termination and redevelopment (Christudason, 2009; E. S. Ti, 2022). This article aims to identify and present the challenges associated with the implementation of strata subdivision termination. It further examines various

solutions proposed in the existing literature to mitigate these challenges. The objective is to provide valuable insights and practical guidance for overcoming the obstacles faced in the process of strata subdivision termination. Following this introduction, the subsequent section of this article will provide an overview of strata subdivision termination, followed by the challenges and the proposed solutions.

## UNDERSTANDING THE STRATA SUBDIVISION TERMINATION

### Strata Ownership and Termination of Subdivision

Strata title ownership, alternatively referred to as multi-owned ownership, represents a legal structure wherein individuals hold ownership rights to their specific parcels within multi-unit buildings while also sharing responsibilities for the maintenance and upkeep of the common property (Easthope et al., 2020). This property ownership concept is also called condominium or apartment ownership and it was introduced as a way to simplify and enable ownership of apartments (Cagdas et al., 2020; Geis, 1982; Shukri & Maidin, 2010; Teo Keang Sood, 2020). It allows individuals to own a unit within a multi-parcel development, such as an apartment building, townhouse, or office building. Before strata titling is implemented, all the parcels in a multi-unit building are jointly held by the purchasers, making transactions and building management difficult (Easthope et al., 2020; Van de Merwe, 1994).

Within the strata ownership system, a dual ownership structure exists, encompassing ownership of shared common areas like hallways, elevators, and staircases, alongside individual ownership of specific parcels (Troy et al., 2017). Ownership of the common areas in a property is vested in the management corporation, comprising all parcel proprietors. In order to register an individual parcel with a document of title, the building must first undergo subdivision, creating individual strata plans that clearly define the property

boundaries. This document serves as a legal instrument facilitating various transactions, such as transfers, liens, leases, and mortgages, enabling the trading and dealings of parcels within the property.

The land of the subdivided building can be transferred to a third party, much like any conventional land ownership, however, it must go through a lengthy process of getting approval from the parcel owners (Lim, 2010; E. S. W. Ti, 2019). The second layer of ownership, which consists of the strata ownerships created by the subdivision of the building, must be terminated first to ensure that the ownership is reduced to shared ownership of the land. The termination or dissolution of a property title is closely linked to the right to property, necessitating a valid and justifiable reason for such termination to be considered and approved (Crommelin et al., 2020). In certain jurisdictions, such as Malaysia, the purpose of termination is limited to three specific scenarios; the complete destruction of the building, partial destruction of the building with a request from owners to demolish the remaining portion, or when a single proprietor owns all the parcels within the building (single proprietorship) (Strata Title Act 1985 (Act 318), 1985; Khadijah & Hadi, 2014; Shukri & Maidin, 2010; Zakiah & Khadijah, 2016). In comparison, Singapore has different requirements for termination. These include the declaration of the land as acquired under the Land Acquisition Act (Cap. 152), the presence of damage or destruction to the building, or an application made to the court by the proprietors, mortgagee, or the management corporation (MC) for termination (Land Titles (Strata) Act (Chapter 158), 2009). The regulation also extends to high-rise public housing provided by the Housing and Development Board (HDB) (Christudason, 2018).

In New South Wales Australia, there are legal provisions in place that require the termination process to be appropriately guided, involving the participation of multiple departments and organizations to ensure its successful execution (Easthope et al., 2013b; Troy et al., 2015). Strata subdivision termination within the life cycle of a stratified building occurs when there arises a necessity for such action, such as when the building becomes dilapidated and poses safety risks, or when the land's value exceeds that of the existing structure (E. S. W. Ti, 2019). Given that strata buildings are typically located within urban areas, the pursuit of urban redevelopment policies and containment of urban sprawl often require the termination and subsequent redevelopment of economically unviable buildings.

## CHALLENGES IN IMPLEMENTING THE STRATA SUBDIVISION TERMINATION

### *The Impact on Minorities and Vulnerable Individuals*

Multi-owned buildings are naturally filled with people with different interests and goals (Douglas & Goodman, 2018). Thus, it is very challenging to get a unanimous vote from all strata parcel owners as required by the law, particularly in Malaysia (Zakiah & Khadijah, 2016). From the previous research, it was found that this consent threshold was proved to be unrealistic which hindered many redevelopment efforts (Crommelin et al., 2020; Easthope et al., 2013b; Khadijah & Hadi, 2014; Troy et al., 2017; Zakiah & Khadijah, 2016). As a result, laws in Singapore, Australia, Hong Kong, and British Columbia have undergone amendments to reduce the requirement for unanimous to supermajority consent, with approval rates ranging from 90% to 75% (Lin et al., 2022; E. S. Ti, 2022; Zakiah & Khadijah, 2016). Those who do not give any consent to the termination are called the minorities, while those who are at higher risk of experiencing the adverse impact of termination are called the vulnerable (Easthope et al., 2013a; E. S. W. Ti, 2019).

Conservatively, the government has the authority to strip individuals of their ownership rights through land acquisition, a process that is regulated by specific legislation (Goswami, 2016). However, with amended regulations that allow supermajority consent, private owners

now possess the ability to terminate the ownership rights of others or to refuse others to dispose of their property. This shift has altered people's perception of their property rights (Easthope et al., 2013a). Still, when it comes to compensation, strata subdivision termination offers more leverage to demand higher amounts and greater authority to refuse offers that do not meet their specific needs, as opposed to the forced termination process outlined in the Land Acquisition Act (E. S. Ti, 2020; Yoshino & Paul, 2019). In this context, it causes minorities and vulnerable people who have been ousted to be forced to relocate, which leads to displacement and gentrification (Leshinsky et al., 2018).

There is also tension between owner-occupier and investor-owner, where the latter will make decisions based on monetary considerations rather than sentimental ties to the property as a place to live and for social support (Crommelin et al., 2020; Easthope et al., 2013a). When this happens, without proper control by the required authority, the land can be redeveloped into a high-end development and creates the potential for speculative buying which causes price volatility in the property market (Chau et al., 2021). This in turn will create social segregation and push vulnerable people to the edge of the city for affordable homes (Chau & Wong, 2014; Christudason, 2012; Leshinsky et al., 2018). This has created a challenge for the government to coordinate the strata subdivision termination to the future planning and rezoning of the city.

The displacement of vulnerable residents, especially individuals who are lower-income and elderly, is a significant concern associated with the termination. These individuals may be disproportionately affected by the loss of control over their property and inadequate compensation (Christudason, 2018; Easthope et al., 2013a). Termination should not only be about financial gain and investment return, but should also consider the social, emotional, and political impact on the residents involved (Troy et al., 2017). Critics also argue that strata subdivision

termination can result in the loss of local heritage, disruption to established communities, and reduced social cohesion (Christudason, 2018; Easthope et al., 2013a). This is because, it will cause people to be forced out of their homes and their familiar surroundings, causing anxiety and a change of lifestyle (Christudason, 2018; Sherry, 2020). The potential reduction of owners' rights and weakened protection against forced dispossession under the amended legislation contributes to this concern.

### The Social and Economic Consideration

Another significant challenge lies in convincing all owners to undertake redevelopment efforts for older, yet well-maintained buildings, as the process may be met with resistance (Crommelin et al., 2020). This happens to low-density and vintage buildings that are situated in a prime area fit for a higher density and mixed-use development that could also benefit from the nearby transportation hub (Ibraeva et al., 2020). The termination process of this nature requires intervention from existing planning policies to determine whether an increase in building scale should be permitted. Such a decision would have implications for urban design, streetscape, population growth, and the strain on existing public amenities. Moreover, the legislation does not prevent the proprietor from selling or transferring their own property, therefore the issue of failing to receive investment returns should not be the main reason for the legislative amendment to lower the consent threshold (Troy et al., 2017). Opting for refurbishment or regeneration of the building and its surrounding area is a more relevant choice than embarking on the intricate process of termination.

The process of acquiring a strata scheme, terminating and demolishing the existing building, and undertaking redevelopment to construct new structures entails substantial costs and time investment. Easthope (2013) highlights that one of the challenges associated with strata termination and redevelopment is

determining the feasibility of development and how it aligns with urban planning considerations. Choosing to buy individual units within a strata building separately proves to be significantly costlier compared to opting for a collective sale. (Easthope et al., 2013a; E. S. Ti, 2022) The extended timeframe and the possibility of owners demanding higher sale prices present notable obstacles, as they can result in the original seller losing out and potentially causing a holdout situation for the collective sale of the remaining parcels. Additionally, the significance of the future development value of the land cannot be overlooked as it determines the viability of investing in redevelopment (Christudason, 2010). Therefore, it is essential to implement stricter planning controls to ensure that the region can be rezoned to accommodate higher-density development, thereby maximizing the investment's potential returns. However, this shift may exert pressure on the current area, leading to increased congestion, inadequate availability of open spaces, overcrowded schools, and strain on other public facilities.

### The Questionable Use of Share Unit as Voting Determinant

In addition to the disagreement over the consent threshold, there are also disputes surrounding the voting method employed in the process. In Malaysia, the legislation for the termination in strata subdivisions mandates a unanimous resolution, which excludes invalid votes (Strata Title Act 1985 (Act 318), 1985; Khadijah & Hadi, 2014). This creates a conflict in the decision-making process when invalid voters, who are still valid property owners as registered in the registered document of title, are prohibited from participating in matters concerning property rights, due to their outstanding maintenance fees owed to the MC. In accordance with Western Australia's strata legislation, namely the Strata Titles Act 1985 (Western Australia) stated that the voting criteria for strata subdivision termination are based on the majority decision of the lot owners which is grounded on the proof of ownership rather

than the share unit (E. S. Ti, 2022). In this context, the voting determinant based on the show of hands which represents the ownership is a more constitutional method due to its relation to the right of property. This is because, the strata title document plays a significant role in establishing strata ownership (N. Khublall, 1995; Shukri & Maidin, 2010; Teo Keang Sood, 2020). This legally recognized document verifies an individual's ownership of a specific unit within the strata development. Apart from that, the share unit formula that is based on the floor area basis fails to account for the limited access and benefits that certain parcel owners have in relation to specific limited common properties or their level of usage (Teo Keang Sood, 2023; E. S. Ti, 2020). Unlike property valuation, which considers the current market value, the share unit formula in certain countries such as Malaysia and Singapore rely on fixed weighting factors. This means that certain groups of owners within a mixed-use development may have unequal voting rights because the fixed weights have a significant impact on the calculation of majority share values (Altmann & Gabriel, 2018; Christudason, 2010; Teo Keang Sood, 2023).

## METHOD

This narrative review research utilizes document analysis as the primary methodology, focusing on examining relevant journal articles related to strata subdivision termination. This approach is selected due to its ability to provide a comprehensive perspective on the topic and access peer-reviewed literature, offering a reliable single source of knowledge (Baumeister & Leary, 1997; Green et al., 2006). The initial phase involves searching for articles related to strata termination on Scopus, with subject areas limited to social sciences. This search yielded five relevant articles. However, upon careful review, only two articles proved to be directly relevant to the research topic. To address the limited number of results from Scopus, the author employed the Connected Papers method, using the most cited article by Troy et al. (2017) as the starting point. This approach

allowed the authors to discover additional related papers by exploring the citations and references within these articles.

By adopting this methodology, the research aims to gather a more comprehensive understanding of strata subdivision termination, utilizing a broader range of sources beyond the initial Scopus search engine. This approach also enables the author to identify and examine similar papers, establishing connections based on the citations and references made by other articles within their respective journals. A total of 69 articles were discovered to be related to the initial article, comprising 20 citations and 49 references. From this pool, the most cited and highly influential articles were selected for further analysis. These articles include Crommelin (2020), Easthope et al. (2008, 2013a, 2013b, 2020), Ti (2022), and Christudason (2010, 2012, 2018).

During the second phase of the research, a thorough reading of the selected literature was conducted, with a specific focus on identifying the challenges and solutions associated with the implementation of strata subdivision termination. By carefully examining the selected literature, the key findings and themes relevant to the research objectives were extracted and synthesized. This process allowed for a comprehensive understanding of the challenges and potential solutions associated with the implementation of strata subdivision termination. Additionally, articles that did not directly relate to the research objectives were excluded from the analysis to ensure focus and relevance (Saz-Gil et al., 2021). The data analysis for this research was conducted using the software tool Atlas.ti. It is a qualitative data analysis software that assists researchers in organizing, coding, and analysing qualitative data, such as interview transcripts, documents, and other text-based sources. By utilizing Atlas.ti, the researcher was able to import and manage the research data efficiently (Susanne Friese, 2012). The author's interpretation of these themes and key findings is presented in Table 1.

Based on the result, articles authored by renowned scholars, including Troy, Easthope, Crommelin and Christudason, and the more recent contribution by Edward Ti have made significant contributions to the field, offering valuable insights and analysis on aspects of strata subdivision termination and urban redevelopment within the context of this research. Their works provide a solid foundation for understanding the subject matter and offer perspectives based on their expertise and research findings. This finding happened to relates to strata legislatives in Australia and Singapore. It is known that Singapore's strata legislation in originated from the Conveyancing (Strata Title) Act 1961 in New South Wales, Australia (Teo Keang Sood, 2023). This legislation also influencing the existence of other strata legislations such as British Columbia, Malaysia, New Zealand and United States of America (Teo Keang Sood, 2023). This historical connection highlights the cross-border influence and adaptation of legal frameworks in different jurisdictions, demonstrating the interconnectedness of strata-related practices and regulations around the world.

## RESULT AND DISCUSSION

**Table 1** Challenges and Potential Solutions by Selected Authors

| Challenges | Solution | Author |
|---|---|---|
| **Negative impacts on** | Potential solutions for strata subdivision termination challenges: enhancing | Troy (2017) |

| | consent method, redefining expectations, public education, and support initiatives | Christudason (2010, 2012, 2018) |
|---|---|---|
| **minorities and vulnerable people** | | Crommelin (2020) |
| **Social and economic pressure** | Enhancing strata subdivision termination through building age considerations and policy adjustments: promoting wellbeing, affordability, and sustainable urban development | Troy (2017) Christudason (2010, 2012, 2018) Crommelin (2020) Easthope et al. (2013a, 2020, 2008) Ti (2022) |
| **Unfair Sales allocation and voting determinant** | Reforming voting procedures in strata subdivision termination: addressing consent thresholds, limiting judicial role, and formation of strata renewal committees | Christudason (2010, 2012, 2018) Easthope et al. (2013a, 2020, 2008) Ti (2022) |

Table 1 highlights the challenges of strata subdivision termination and redevelopment, despite its effectiveness in facilitating urban redevelopment for the overall benefit of the community. Christudason strongly opposes the reduction of the consent threshold in Singapore, expressing concerns about the potential displacement of minorities and a lack of good faith during the termination process. Similarly, in Australia, Easthope et al. and Crommelin criticize the amendment of the Strata Scheme Development Act in New South Wales, which allows for a supermajority consent of 75% for strata termination. Their concerns also include the potential displacement of minorities and changes in the definition of ownership. On the other hand, Ti (2022) maintains a positive outlook on the process but raises concerns about the use of share units for sales allocation purposes due to perceived injustices. In contrast to other authors, Ti suggests that the courts should respect the decision of the majority and not disregard it, even If the minority expresses unwillingness towards the collective sale of the strata property. It is evident that although the authors disagree with certain aspects of the implementation, they propose several suggestions to enhance the process, with a particular focus on protecting the Interests of minorities and vulnerable individuals affected by it.

Christudason (2018), Easthope (2013), and Troy (2017) extensively discussed the challenges associated with termination and redevelopment, particularly focusing on the right to property and the impact of displacement. These scholars highlighted the significant implications these issues have on affected individuals and communities. The impact of termination and redevelopment can extend to all parties involved in the process, regardless of their consent. This is because individuals might not have sufficient knowledge about the optimal value of their property or the appropriate amount of compensation they should accept. As a result, they may inadvertently make decisions that have long-term consequences on their interests (Leshinsky et al., 2018). The uncertainty surrounding future developments introduces a risk to individuals' future prospects as well, particularly if their replacement housing is contingent upon those developments. Being relocated away from their current neighbourhood can create additional pressures, especially for elderly individuals or those with disabilities who find comfort in familiarity (Crommelin et al., 2020). These individuals rely on a sense of belonging and support networks within their current community, making such a transition challenging and potentially detrimental to their overall well-being.

Based on the extensive research conducted by the authors listed in Table 1, several relevant solutions for each highlighted challenge are proposed as elaborated below.

***Solution Through Improvement of Implementation Process for Negative Impacts on Minorities and Vulnerable People***

The suggested solutions by the authors primarily centre around the implementation process, aiming to ensure that strata owners affected by termination have a thorough comprehension of the consequences and can make informed decisions about their properties. Troy stressed out on the involvement of the government and various stakeholders that are pivotal in providing comprehensive and easily accessible guidelines. Easthope et. al (2013, 2020) agree that providing access to free advocacy services can empower strata owners and residents on their right to property, particularly those who may be more vulnerable or disadvantaged. These services can offer guidance, support, and legal assistance throughout the termination process, ensuring that all stakeholders have a fair and equitable voice.

Christudason (2012) and Troy (2016) promote public awareness and understanding of strata subdivision termination because it can foster informed decision-making and alleviate any misconceptions or resistance. During the termination process, it is crucial to offer comprehensive support and guidelines to affected residents. This includes addressing relocation and compensation concerns, providing clear information about their rights and entitlements, and facilitating a smooth transition to alternative housing arrangements, if necessary.

In order to reduce the negative impact of termination towards different needs of strata owners such as owner-occupiers and investor-owners, Christudason proposed to differentiate consents based on the categories of owners. However, this may introduce additional bureaucracy and complexity to the termination process. This is because, it is possible that owner-occupiers and investor-owners may have similar goals and concerns in certain cases, while there can also be variations within each category. Therefore, while Christudason's proposal seeks to address the diverse needs of strata owners, it is important to carefully evaluate the potential complexities and challenges associated with implementing such differentiation.

***Solution Through Policy-Making for Social and Economic Consideration***

Some of the authors suggested that the successful implementation of strata subdivision termination for urban redevelopment relies on the adoption of specific policies. For instance, Easthope (2013) opined that the development of affordable housing options is seen as a beneficial policy to promote inclusivity within the process. A crucial technical factor to consider is the age of the building, as it should be taken into account prior to initiating the termination process. This consideration ensures that the redevelopment is undertaken strategically and effectively, taking into account the condition and suitability of the existing structure.

Implementing specific criteria to evaluate the impact of termination on the wellbeing of residents is essential. This assessment should consider factors such as the availability of alternative housing options, access to essential amenities, and the overall quality of life for affected residents. Ti (2022) suggested that careful consideration should be given to determine whether redevelopment is genuinely necessary. This involves evaluating the feasibility of refurbishment to extend the lifespan of existing buildings while meeting safety and sustainability standards.

Policy also plays important role in ensuring the successful implementation of strata subdivision termination. As Easthope (2020) mentioned in his article, encouraging the concept of "ageing in

place" can be achieved by providing necessary support services, adapting units for accessibility, and fostering a sense of community for older residents. This involves creating provisions that allow elderly residents to continue living in their current strata properties if they desire. Apart from that, incorporating affordable housing options within redevelopment plans is crucial to ensure inclusivity and prevent the displacement of vulnerable populations. Easthope (2013, 2020) proposed that this can be realized through regulatory mechanisms and incentives that encourage developers to include affordable housing units within their projects.

Prioritizing the improvement of local infrastructure and transport networks around strata properties can enhance the overall liveability of the area. This includes ensuring adequate access to public transportation, community facilities, green spaces, and other essential amenities. Enhancing government involvement in the termination process and allowing amendments to legislation can ensure greater equity and fairness, as muted by Easthope (2009). This can involve creating regulatory frameworks that safeguard the rights of all stakeholders and address potential disparities in the termination process.

### Solution Through Legislative Improvement for Unfair Sales Allocation and Voting Determinant

In light of comparative analysis across various jurisdictions in Australia, Ti (2022) proposes a noteworthy suggestion regarding the termination process. He emphasizes that termination should not be perceived as forcibly displacing individuals from their properties, provided that the majority of owners agree to the process and receive adequate compensation (E. S. Ti, 2022).

This recommendation underscores the importance of government intervention in ensuring a fair and transparent termination and urban redevelopment process. By actively participating in the process, the government can foster an environment of good faith, facilitate necessary assistance, and help ensure the success of the redevelopment project (Zhang et al., 2019). Such involvement is essential to balance the interests of all stakeholders and to promote a harmonious transition toward urban revitalization. Ti's proposal to limit the power of the courts stems from instances such as the well-known case of Horizon Tower in Singapore, where a collective sale was cancelled by the court due to evidence of improper decision-making despite majority consent for termination. Such cancellations can be both timely and costly.

In his article, Ti also mentioned the importance to honour the democratic decision by the majority of strata owners to terminate the scheme and that the responsibility of the court is to ensure that the process was done within the context of 'just and equitable'. Ultimately, the aim is to create a system that respects the will of the majority while also considering the legitimate concerns and interests of the minority. By finding this equilibrium, the termination process can be conducted in a manner that is both efficient and fair, promoting a harmonious transition for all parties involved.

In addition to curbing jurisdictional power, there is a recommendation to enhance the sales allocation process by valuing the strata property based on its market value, rather than solely relying on the share unit entitlement. Ti argues that this valuation-based approach promotes fairness and equity, unlike the potentially problematic share unit formulation. This method can be adopted in other jurisdictions, such as Malaysia and Singapore, that utilize the share unit entitlement based on floor area as the basis for allocation (Teo Keang Sood, 2023; E. S. W. Ti, 2019).

### CONCLUSION

In conclusion, strata subdivision termination and redevelopment are essential for the realization of sustainable and inclusive cities for future generations. The necessity for termination arises from factors like land scarcity, increasing land values, building safety issues, and the

<u>objective of building sustainable cities. However, there are significant challenges and considerations to overcome in this process. The demand for unanimous consent from all strata parcel owners is often unattainable, prompting the need for legislative adjustments that permit supermajority consent.</u> By effectively tackling these challenges through the improvement of implementation process, policy and legislative amendments, it becomes possible to promote successful strata subdivision termination and redevelopment initiatives that actively contribute to the creation of sustainable and inclusive urban environments.

The impacts of strata subdivision on residents can be viewed from two perspectives: those who welcome it and those who oppose it. It can be seen that the impact reduces the right to property to a mere financial transaction, or benefitting the financial and economic situation for both owners and the local community.

In New South Wales, legislation ensures that for every resident displaced, a replacement is provided to prevent homelessness. Additionally, the compensation received exceeds the original property cost, including associated encumbrances. This method can reduce the stress related to the loss of ownership right.

The urban redevelopment itself has faced criticism, particularly regarding gentrification and the displacement of local residents. investor-owners, as opposed to owner-occupiers, are more likely to support termination due to their financial motivations. Owner-occupiers often have strong emotional and social ties to the existing community. Hence, legislation should prioritize in-situ replacement, ensuring that residents receive a new housing option and access to essential amenities within the same land or vicinity, thus safeguarding their quality of life during the redevelopment process.

While strata subdivision termination and redevelopment present opportunities for progress, it is crucial to acknowledge their potential challenges, including concerns related to minority groups, vulnerable individuals, displacement, and gentrification. Achieving a balance between financial considerations and social and emotional impacts is paramount to ensure equitable outcomes. It is important to also prioritize the preservation of local heritage, community cohesion, and protection against forced dispossession. Efforts should be made to promote effective representation among owners, foster transparency, and provide fair compensation to those affected by displacement. By raising awareness of these complexities, this article aims to provide guidance to strata communities, professionals, and policymakers in navigating the intricacies of strata renewal and promoting sustainable and inclusive urban development.

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# PROMOTING GREEN AGRICULTURE AND RURAL DEVELOPMENT IN POST-MODERN CHINA: ISSUES, CHALLENGES AND FUTURE RESEARCH

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## ABSTRACT

This article provides a comprehensive review on China′s effort in promoting green agriculture program as the way to transform and upgrade the agriculture sector and promote sustainable livelihood for rural/agrarian community. The development of green agriculture is of great significance in many aspects, such as increasing farmers' income. Based on theories related of sustainable green agriculture,Green Development Theory, and Ecological Economy Theory，this article compares various literature on the development of green agriculture, green agriculture development efficiency, and green agriculture mechanism for rural development in post-modern China. Findings from the review indicated few issues and challenges including, the shortcomings of the existing research related to weak systematization for promoting green agriculture, lack of case studies and quantitative research for improving mechanism for promoting agriculture products and services efficiency. The review concluded by suggesting more attention and relevant research should be given for developing a more effective mechanism for managing credit and insurance mechanisms for green agriculture promotion particularly among rural farming households.

*Keywords : Green Agriculture, Rural Development, Post-Modern China, Agriculture Development Theory, Case Studies*

## INTRODUCTION

This Green agriculture, as a new model of agricultural development, emerged in the 1920s. Initially, the concept of "green agriculture" was not simply a generic term, but the corresponding concepts in foreign countries were agroecology, organic industry, and so on. The idea of sustainable agriculture began with a focus on food, first proposed by Australian agronomist Gordon McClymont in 1950.

In 1996, British environmental economist David Pearce defined green development as a sustainable development model that takes into account both economic efficiency and ecological and environmental capacity (Pierce D, 1996). In the process of China's green development, China's attention to green development began in 2009, when Hu Jintao took the lead in proposing the need to "vigorously develop the green economy, low-carbon economy, and circular economy", and endeavored to present to

the world a decoupled relationship between economic growth and environmental pollution. Through in-depth inquiry, green development is categorized into three modes: green growth, green wealth, and green welfare, and it is argued that green development means that economic growth is built on a green and inclusive growth trajectory(Hu A. G. et al., 2014).·In 2012, the concept of agricultural green development has gradually become the mainstream direction of China's agricultural and rural development. Agricultural green development was first proposed in 2017 in the Implementation Opinions on Innovative Institutional Mechanisms to Promote Agricultural Green Development, before which agricultural green development mainly appeared in the form of organic agriculture, green agriculture, ecological agriculture, and sustainable agriculture, etc. Agriculture, as a basic industry in China, is only logical to promote its green development (Sun X. et al., 2021). Beginning in 2017, the government issued

a series of documents related to green development of agriculture, and at the same time, China's literature research on the green development of agriculture has also increased. Agricultural green development is an important measure to accelerate the modernization of agriculture, and it has important scientific significance for promoting the construction of ecological civilization in China. With the rapid development of China's economy, resource and environmental problems have become increasingly severe, and General Secretary Xi Jinping's idea of green development has emerged (Qin S. S. et al., 2015). According to General Secretary Xi Jinping, the essence of green development focuses on revitalizing the countryside and building a beautiful China and proposes that the relationship between the economy and environmental resources should be correctly handled to promote green development. At the same time, China's literature research related to green agricultural development has also increased.
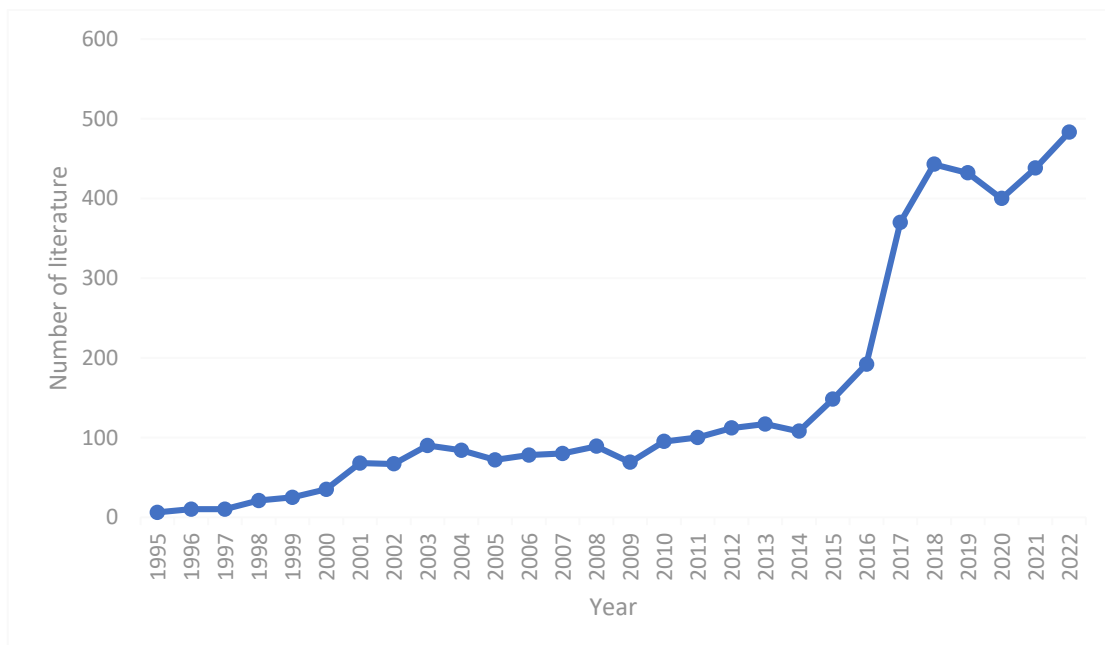


**Figure 1** Amount of research literature on green development of agriculture in China, 1995-2022

According to the search results, Figure 1 shows the number of literature related to green agricultural development in China for each year starting from 1995. From Figure 1, it can be seen that the number of literature in the field of green agricultural

development is generally on an upward trend.

From the perspective of rural areas and development, in order to help revitalize the countryside, realize ecological idylls and. build a beautiful countryside, the Minister of Agriculture of China, Han Changfu, pointed out that the profound connotation of green development in agriculture stems from the four "more": that is, the gradual improvement and development of the four levels, namely, resource-saving, environmentally friendly, eco-protection, product quality, and so on (He P. M. et al., 2018). In general, the development of green agriculture is the realization of the concept of "green agriculture". In general, the development of green agriculture is a necessary way to realize the sustainable development of national agriculture. To promote the comprehensive green transformation of economic and social development and accelerate the improvement of the ecological environment, it is necessary to change the traditional concept of agricultural development and take the road of green agricultural development. The development of green agriculture is studied by combing the literature related to green agriculture in China. This paper mainly focuses on green agriculture development issues, green agriculture development efficiency and green agriculture mechanism focus areas for literature combing, to provide new ideas and references for green agriculture development research.

## THEORETICAL BASIS FOR GREEN AGRICULTURE DEVELOPMENT

### 2.1 Green Development Theory

The sustainable development of green agriculture is the process of gradually shifting from inefficient agriculture to efficient and sustainable agriculture to improve product quality and quantity, protect the ecological environment, and realize the sustainable use of resources. By sorting out the development process of green agriculture, we analyzed the development status of green agriculture in China by combining the relevant indicators of domestic green agriculture development in the past ten years, revealed the interaction between green agriculture and economic development, and from the perspective of green agricultural products, explored the problems existing in the development process of green agriculture, and put forward suggestions to promote the sustainable development of green agriculture (Wang D, 2021). In the process of building an ecological civilization society, it is necessary to accurately grasp the planning of ecological civilization construction, balance the relationship between the sustainable development of agriculture and the construction of ecological civilization, and change from attaching importance to yield to attaching importance to quality, so as to make the green, high-quality and sustainable development of agriculture (Ling G. M, 2021).

### 2.2 Green Development Theory

The theory of green development originated in the 1987 study Our Common Future and was marked by the World Conference on Environment and Development, held in Rio de Janeiro in 1992. It is widely recognized internationally that green development is one of the connotations of the concept of sustainable development, which focuses on revolutionizing the way of thinking to solve existing resource and environmental problems. Chinese scholars have also made important interpretations of green development, pointing out that green development is the transformation of the mode of economic development (Yu F. W,

2019). It is a new way of development that harmonizes the relationship between the economy and ecology and plays an important role in improving the human living environment (Zheng D. F. et al., 2018). According to Huan Q. Z, three aspects are indispensable for understanding and defining green development: ecological sustainability, environmental friendliness, and sustainable growth of the environment and resources (Huan Q. Z, 2020). Scholars are gradually realizing that it is an important practice for the development of today's world and contemporary China to develop a green economy and seek the path of green GDP development (Liu E. Y. et al., 2021). Therefore, green development has become an inevitable choice for China's current and even future economic development mode for a considerable period. As a new green development model, the theory of green development, from the point of view of agricultural and rural development, mainly emphasizes the environment of agricultural production, the safety and ecology of the quality of agricultural products, and the enhancement of social and economic benefits (Li Z., 2016).

2.3 Ecological Economy Theory

Ecological economics is a model that combines the perspectives of ecology and economics based on ecological and economic issues, to achieve a balanced and coordinated development of ecology and economy (Fan Q. 2019). The concept of "ecological economics" was developed by the famous economist Boulding to eliminate ecological and economic development problems related to real society (Li Z. 2017). The earliest exploration in China was in 1973 when China's first environmental protection conference included the topic of environmental protection in the strategy of China's economic development program. In 1980, Xu D. X., a famous Chinese economist, initiated and convened the first symposium on the ecological economy in China, which kicked off the national ecological economics, and in August of the same year, he first proposed the goal of "gradually establishing China's ecological economics", and in September of the same year, he published China's first collection of essays on ecological economics, On Ecological Balance, and in 1987, Ecological Economics was published, marking the initial formation of China's theory of ecological economics. In September, China's first collection of essays on ecological economics, On Ecological Equilibrium, was published. The publication of Ecological Economics in 1987 marked the initial formation of China's ecological economics theory (Li Z. 2020).

## CURRENT STATUS OF RESEARCH ON GREEN AGRICULTURE

3.1 Research on Green Agriculture Development

As early as the 1970s and 1980s, the idea of green agricultural development had already emerged in China, and it was in 2003 that the concept of "green agriculture" was officially proposed. Since entering the twenty-first century, China has made fruitful achievements in green agriculture development (Li M., 2022).

The analysis of the Menyuan Basin in Qinghai Province, China, which has various advantages such as the existence of the environment, the development of green agriculture can change its former poverty plight, avoid the "high carbon trap" of rural agricultural development, and bring the region directly into a green, modern state (Chen L. S. et al., 2006). In another research on green agriculture in the Qinghai-Tibet. By investigating and dividing the green agricultural resources in the Qinghai-Tibet region into regions, the market positioning and marketing system was constructed according to the production and marketing status of green foods in the Qinghai-Tibet Plateau region, and suggestions were made that publicity and technical research should be increased (Chen Z. Q., 2010). Based on the first batch of 40 national green

development pilot zones, five typical agricultural green development models were summarized using data statistics and case studies (Luo J et al., 2020). In the process of developing green agriculture, cities should carry out comprehensive layout planning, create public brands of agricultural products, and it is essential to increase financial investment (Zhu X. Y., 2020). In the current development process of green agriculture in Hunan Province, technology is an important factor that restricts its development and also promotes its development. Strengthening the communication between green agriculture policy and agricultural technology may become a new growth point for promoting green agriculture in the future (Xu X et al., 2020). By sorting out the value orientation of 3 levels of agricultural green development, from the value level of resource scarcity and guaranteed supply and demand structure, and the socio-spatial structural relationship of resource allocation, to recognize the multiple disturbances of balance and equilibrium in the development of agriculture in today's society, and the problems that eco-agriculture can solve; from the policy orientation and ethical care of agricultural economy, the researcher discusses the necessity, orientation, adaptability, and the necessary conditions for subjects to choose green agriculture (Cao Q. M., 2020).

At present, the research direction of green agriculture development is mainly to use statistical analysis and field research methods to analyze the current situation of green agriculture development in the author's study area, point out the problems of green agriculture development in the area, and put forward corresponding policy suggestions based on the existing problems; based on field research or data analysis, summarize the typical patterns of green agriculture development in the study area and put forward corresponding policy suggestions in response to the existing problems. Based on field research or data analysis, we summarize the typical models of green agriculture development in the

study area and put forward corresponding suggestions for countermeasures.

3.2 Research on the Efficiency of Green Agriculture

Evaluation of the efficiency of green agriculture, i.e., assessing the degree of utilization of the resources of China's agricultural economy under the current conditions of inputs and technology. By evaluating the efficiency of green agriculture, it is possible to effectively measure and determine the degree and level of development of current green agriculture, and to identify the problems that exist in the process of current green agriculture development to put forward corresponding policy recommendations.

The DEA model (Data envelopment analysis) and entropy method (It is a measure of uncertainty). were used to measure green agricultural output and technical efficiency of green agriculture in China, and the differences between provinces were analyzed, concluding that two-third of Chinese provinces are in a low but growing trend of technical efficiency of green agriculture (Huang A. S. et al., 2014); the SBM-Undesirable model was used to measure China's green grain production efficiency from 2003-2017, using Tobit model to test the relationship between green grain production efficiency and the role of various subsidy policies in green agriculture, confirming that agricultural policy support is positively correlated with production efficiency, but the result that agricultural machinery purchase subsidies are not significantly negatively correlated with production efficiency, and that the subsidy structure should be optimized, the subsidy mechanism should be standardized, and the Policy recommendations for optimizing subsidy structure, standardizing subsidy mechanism, and strengthening performance management (Zhang C. M. et al., 2020).

On the other hands, the efficiency of green agricultural development in Henan Province was evaluated using gray system

theory modeling software, and it was concluded that Henan Province is in the inefficient mode of high input and low output, which is a more sloppy agricultural production mode, and relevant suggestions should be made to strengthen the construction of green agricultural organizations and scientific and technological innovation (Yang Z. M. et al., 2019); analyzing the data of Shandong Province from 2011 to 2018 data statistics, combined with the "short board effect" using SBM-DEA three-stage analysis method to measure the agricultural green production efficiency of regions within each economic circle in Shandong Province, pointing out that infrastructure is a factor that hinders the improvement of local agricultural green production efficiency; Shandong Province has agricultural resources deployment Irrational phenomenon, should focus on the integration of the three industries in the follow-up process of green agriculture green agricultural development, pay attention to the balanced development of green agriculture in Shandong Province, according to local conditions, and focus on the driving effect of excellent areas (Shang J. et al., 2021).

Total factor productivity, i. e. the efficiency of production activities over a given period. It is a productivity indicator that measures the total output per unit of total input. The growth rate of total factor productivity measures the degree of scientific and technological progress, which mainly includes technological progress, organizational innovation, specialization, and production innovation. Based on the information from China's agricultural development statistics to reshape the agricultural input-output index, the Luenberger index of the SBM-DDF method was used to measure and analyze the spatial and temporal evolution and convergence of agricultural green total factors in 31 Chinese provinces from 2001 to 2015, pointing out that Chinese agricultural green total factor productivity is still at a low level, and the actual total factor productivity gap should be narrowed by strengthening inter-regional exchange and cooperation and improving agricultural production technology and management experience (Ge P. F. et al., 2018).

In terms of green agricultural efficiency research, the topic is no longer limited to green agricultural efficiency measurement; the research method is still mainly the DEA model.

## 3.3 Research on the Efficiency of Green Agriculture

In terms of the power and driving force of green agriculture development, based on the theory of institutional change and analyzing the driving factors and their mechanisms and pathways within and outside the promotion of green agriculture, we have constructed and perfected a model of the power of green agriculture development system (Zhao D. W., 2012).

About the financial mechanism of green agriculture, we have sorted out and analyzed the causes of financial difficulties faced by green agriculture development, and pointed out that there are three exogenous financial difficulties in green agriculture development, namely, endogenous and restricted agricultural financial funds, an insufficient supply of financial funds and limited investment of social funds; endogenous financial difficulties cause exogenous difficulties in green agriculture development, and we should strengthen the construction of green agriculture investment and financing mechanism. To fundamentally solve the financial difficulties of green agriculture development, we should promote and construct the green agriculture certification system and credit system, and play the joint role of finance, finance and insurance (Hu X. P. et al., 2015). By optimizing the allocation of rural financial resources, introducing Internet financial tools, and constructing a green agriculture financial inducement mechanism based on credit support, insurance protection, and price protection, it is proposed that farmers should be motivated to develop green agriculture through active policies (Zhang

W. et al., 2019).

In terms of ecological compensation for green agriculture, based on externality theory, it is believed that the accumulation of ecological capital in green agriculture is the basis for the operation of ecological capital in green agriculture, and a sound mechanism and perfect policies are the guarantees for the accumulation of ecological capital in green agriculture (Yan L. D. et al., 2011); using hierarchical analysis and fuzzy synthesis analysis, we analyzed the implementation effect of ecological value, economic value, and social value in three aspects. The implementation effect of the ecological compensation policy for green agricultural production in the East-West Lake area of Wuhan City was analyzed by using hierarchical analysis and fuzzy comprehensive analysis, and it was concluded that the ecological compensation policy has played a certain role, and efforts should be made in terms of policy implementation and ecological capital utilization efficiency to further improve the implementation effect (Deng Y. J. et al., 2015).

In terms of regional synergistic development of green agriculture and urban-rural industrial chain synergistic development, Beijing, Tianjin and Hebei have the problems of insufficient breadth, depth and collaborative content in developing collaborative division of labor mechanism of green agriculture, and to build up a close division of labor and collaboration mechanism, it is necessary to improve the industrial docking mechanism, resource optimization allocation mechanism, improve infrastructure and carry out policy support under the premise of government boosting in the region (Liu G . et al., 2015); based on the perspective of rural revitalization, the concept and operation mechanism of urban-rural agricultural industry chain synergy and the theoretical model of industry chain synergy development with various factors such as relevant factor flow system supply are proposed, and it is concluded that the system, public service

and innovation environment have a direct impact on the two-way flow of urban-rural innovation factors, and they are also the fundamental factors and key to the development of urban-rural green agricultural industry chain synergy. It is suggested that the synergistic development of the urban-rural green agricultural industry chain should be promoted through institutional innovation (Xiong X. L., 2021).

The research on green agriculture mechanisms shows the characteristic of intermingling, which also reflects from the side that the green agriculture operation mechanism is a complementary system. Meanwhile, the vast majority of scholars who study financial and ecological compensation mechanisms put forward proposals for sound credit and insurance mechanisms for green agriculture; in the study of regional cooperative mechanisms, most scholars reach a consensus on government support and institutional supply support.

3.4 Research on the implementation path of green development in agriculture

The transformation and upgrading of green agricultural development is the real embodiment of the implementation of the concept of green development and the construction of ecological civilization in agriculture. The choice of the implementation path of green agricultural development has many influencing factors, the main influencing factors are the agricultural system policy, agricultural capital subsidies, agricultural science and technology innovation and agricultural technical personnel.

The policy is an important guarantee for transforming and upgrading green agricultural development. The research on the transformation and upgrading path of green agricultural development by institutional policies is relatively abundant and mainly focuses on subsidy policies. After analyzing the deep-rooted contradictions and conflicts of interest facing green agricultural development in

China, measures such as implementing a green agricultural environmental compensation system and strengthening the construction of green agricultural infrastructure are proposed (Chu D. J., 2020). In terms of green agricultural production and lifestyle, the implementation of institutional support and subsidy policies should be accelerated to further accelerate the development of green transformation in the new rural economy (Dang Z. J., 2020). In terms of green agricultural development drive, the government should improve top-down effective promotion and bottom-up demand-pull of corresponding subjects, and continuously improve policies (Liu G., 2020); the existing social factors on the transformation and upgrading of agricultural green development mainly focus on three aspects: finance, technology, and talents. In terms of funding, quantitative and qualitative research was used to explore the development of green agriculture in Xinxiang City, and measures such as establishing special funds and opening financing channels were proposed (Du C. J. et al., 2019). In terms of technology, the green transformation and upgrading of traditional agriculture can only be realized if the capacity for technological innovation and intra-regional collaboration is continuously strengthened (Li X., 2021), (Jin S. Q., 2021). In terms of talent, green agricultural production should be carried out by improving the talent support system and encouraging new agricultural operators to take the lead (Zhao G. et al., 2019).

In the transformation and upgrading path of green agriculture, there are more studies on policy transformation and upgrading path and fewer studies on social factors, and most of them focus on the provincial level, and the national level is poor, and the correlation between the two is weak. In terms of policy factors, there are more studies on the policy of agricultural subsidies, but fewer on the interaction between the policy of agricultural industrial system, land policy, and the transformation and upgrading path

of agricultural green development. The research on social factors is shallow in terms of talents. Therefore, the effective integration of both policy factors and social factors should be strengthened, while the development of relevant policies and the support of agricultural technology and talent systems should be accelerated.

## CONCLUSION

At present, the research on green agriculture has not yet formed a systematic disciplinary system, and most of the research is still limited to theoretical aspects. Since green agriculture covers many aspects of green agricultural production and planting, processing, and transportation as well as mass consumption, China should broaden its horizons and focus on the holistic, systematic, and stable development of the whole agro-ecological production system to realize the transformation from modern high-input agriculture to green environmental agriculture. In the study of green agriculture, the scope of green agriculture as a research subject has not yet reached a consensus among scholars. In future research, only by clarifying the subject of "green agriculture", it is possible to explore the development path of green agriculture, and truly realize China's leapfrog transformation from alternative agriculture to green agricultural development. Existing literature mostly starts from the perspective of green agriculture development, but it is less concerned with the problems in green agriculture development.

In terms of the legal system related to green agriculture, China currently lacks the necessary legal support system for green agriculture and has not yet formed a unified standardized management system as well as pricing standards for green products, making it difficult to distinguish between current green products and ordinary agricultural products, which ultimately leads to the blindness of ecological compensation for green agriculture and the loss of motivation of farmers and agricultural enterprises to

develop green agriculture and implement green agriculture. Meanwhile, among the green agriculture mechanisms, the more critical green agriculture credit mechanisms and insurance mechanisms are missing, making green agriculture practitioners bear more risks than alternative agriculture. Future research should do further research on how to establish green agriculture credit mechanisms and green agriculture insurance mechanisms.

Most of the existing studies analyze the current situation and problems of green agriculture development from the perspective of qualitative analysis, and few articles analyze green agriculture and its development problems by case study methods so that the research on green agriculture issues only stays at the research stage. The research on green agriculture is mostly on individual issues and lacks novelty and practicality in terms of political measures and suggestions. Green agriculture development is a practical issue, and field research should be conducted to find better local cases and analyze them to explain common problems of green agriculture development and put forward targeted policy recommendations based on multiple practical factors such as geomorphological features, environment, and ethnicity of the areas studied by the researchers.

In conclusion, green agriculture is a new type of agriculture that ensures the sustainable development of national agriculture, brings into play positive externalities and maintains a good ecological environment, and requires the whole society to have a comprehensive understanding and grasp of it. In the current context of global warming and transformational development, China needs to vigorously promote the development of green agriculture to achieve sustainable agricultural development.

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# A SYSTEMATIC LITERATURE REVIEW OF ARTISAN ENTREPRENEURSHIP DEFINITION

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## ABSTRACT

The extensive use of terminology in the artisan entrepreneurship study served as the impetus for this study. As a result, the authors want to identify, assess, and synthesise the present body of literature on artisan entrepreneurship, as well as to construct and propose a comprehensive definition of artisan entrepreneurship. This paper was written using a systematic literature review (SLR) as a guideline. A total of 16 empirical publications were chosen for review. This research discovered a path that began as an artisan and ended as an artisan entrepreneur in the tourism industry. As a result, artisan entrepreneurship may be classified into three categories: artisan, artisan entrepreneur, and artisan entrepreneur in tourism.

***Keywords : Artisan Entrepreneurship, Systematic Literature Review, Tourism***

## INTRODUCTION

The literature on artisan entrepreneurship is acknowledged as a new and expanding area of entrepreneurship research (Ratten & Usmanij, 2022) , yet the literature on artisan entrepreneurship is noticeably limited (Ferreira et al., 2019). According to a review of general trends in literature, there has been a significant increase in interest in artisan entrepreneurship, and numerous reputable journals have published important studies in this area (Pret & Cogan, 2019). Additionally, due to the rise of the creative industries and a greater emphasis on handmade goods and services with a cultural component, there has been a growing interest in artisan business in the global economy (Ratten et al., 2019).

Therefore, this study explores the various empirical works that categorised their respondents as artisan entrepreneurs. We therefore propose that the aim of this work-in-progress study is to develop a comprehensive definition of artisan entrepreneurship. This study attempts to construct a definition by conducting a thorough evaluation of the artisan entrepreneurship literature. It's a small contribution to the body of knowledge on artisan entrepreneurs. The results of this study will aid scholars, students, tourist managers, and industry players in acquiring a comprehensive understanding of a newly emerging field of entrepreneurship.

## THE EXISTING DEFINITION OF ARTISAN ENTREPRENEUR

The artisan entrepreneur is a person who value the product they have created more than the amount they will received. They are vastly different from other profit and growth oriented entrepreneur (Lindbergh & Schwartz, 2021; Rashid & Ratten, 2021). They transform their hobby into a valuable business (Hoyte, 2019; Ramadani et al., 2017; Ratten & Ferreira, 2017). Thus, the artisan entrepreneur can be viewed from diverse background of skills and knowledge. They fall into broader conceptions of entrepreneurship under the sub-topic of tourism entrepreneurship (Marques et al., 2019). They also been referred to as craftsman entrepreneurship (Bislimi, 2022; Ratten et al., 2019), cultural (Hoyte, 2019), or lifestyle entrepreneurs due to the emphasis on creative industries (Ratten et al., 2019). The artisan entrepreneurs produce clothing and food industries (Tregear, 2005), handicraft (Ferreira et al., 2019) and associated with traditional businesses such as brewers, furniture makers and musicians to those with a technology focus including video game developers and web designers (Kapp, 2017). The variety of concepts and products offered by artisan entrepreneurs makes this study essential to define artisan entrepreneurship thoroughly. The following table 1 shows a few definition of artisan entrepreneur proposed by previous authors.

## RESEARCH METHODOLOGY

This research utilised systematic literature review because many other studies in the entrepreneurial context have conducted review by using systematic review methods (Belitski et al., 2022; Dabić et al., 2021; Korber & McNaughton, 2018; Pret & Cogan, 2019). First, the researcher has to define research objectives in order to effectively generate study findings. Therefore, a thorough definition of artisan entrepreneurship will be developed in this paper.

Second, the Boolean search phrases "artisan entrepreneur*" were used to conduct full-text searches across a wide range of fields and periodicals. This is contradicted with previous scholars such as Pret and Cogan (2019) who applied "(Artisan*OR Craft*) AND Entrepreneur*" as their Boolean search. Over 5,000 preliminary results were produced as a result, although only 2% of them are pertinent to artisan entrepreneurship. This significant inconsistency was mainly due to the various uses of the term "craft", such as "crafting strategy" or "crafting an identity" (Pret & Cogan, 2019). As a consequence, this study solely employs the exact keyword "artisan entrepreneur" to find pertinent publications in the Scopus database. The Scopus database was selected due to the availability of more journals than the Web of Sciences (WOS) (Paul & Criado, 2020). The artisan entrepreneurship is a new emerging study of entrepreneurship. Therefore, the number of studies found is less than 50 publications. Scopus was used to track down a total of 46 publications, including articles, book chapters, reviews, books, and conference papers. 29 articles were chosen after it was filtered simply by article. Only 16 empirical publications with full paper access are examined for further research.

Third, data from the final 16 publications were analysed to determine the research area's location, the data collection method used, the publication year, the articles' original sources, and the journal's quartile index. Second, the process of how the respondents were chosen was the subject of the analysis. This section is extremely important since the findings show what an artisan entrepreneur looks like. It also aids the authors in comprehending the selection process used to classify the respondent as an artisan entrepreneur. The third and last step is developing an operational definition of artisan entrepreneurship.

Table 1: Definition of Artisan Entrepreneur by Previous Authors

| Definition of Artisan Entrepreneur |
| --- |
| 1. Artisan entrepreneurs are in the clothing and food industries, as they prefer to make their own products that are linked to their cultural heritage (Pret & Cogan, 2019) |
| 2. Artisan entrepreneurs have skills, talents, traditions and passions and believe in themselves to realize their particular goal and, respectively, to produce products/ services in limited quantities (Ramadani et al., 2017). |
| 3. Artisan entrepreneurs are encouraged to start and develop enterprises due to lifestyle choices (Arias & Cruz, 2019). |
| 4. Artisan entrepreneurs have been referred to as cultural or lifestyle entrepreneurs due to the emphasis on creative industries (Ratten et al., 2019). |
| 5. Artisan entrepreneurs are a diverse group of people including those associated with traditional businesses such as brewers, furniture makers and musicians to those with a technology focus including video game developers and web designers (Kapp, 2017). |
| 6. There are sub-types of artisan entrepreneurs that need to be distinguished based on tourism competitiveness (Marques et al., 2019). |
| 7. Artisan entrepreneur–mediators in rural areas or small cities take on multiple roles as networking agents who organize and offer creative tourism experiences (Bakas et al., 2019). |
| 9.Emphasize manual production over mass-production, independence over conglomeration, local community over scale, and value creation over profit maximization (Solomon & Mathias, 2020). |

## MAIN RESULTS

### Background of Selected Studies

The final selection of articles consists of 16 papers to be reviewed thoroughly. From 16 articles, 50% of studies were conducted in Europe, 25% of studies in North America, 12.5% of studies in Africa, and followed by Asia and South America with 6.25% of studies. In Europe, three studies were conducted in Portugal (Arias & Cruz, 2019; Ferreira et al., 2019; Marques et al., 2019), followed by one study in Kosovo (Bislimi, 2022), Sweden (Lindbergh & Schwartz, 2021), the United Kingdom (Hill, 2021), Poland (Kwiatkowski et al., 2021) and Macedonia (Ramadani et al., 2017). Four studies were conducted in United States of America (Solomon & Mathias, 2020); Honduras (Arias & Cruz, 2019); the Midwestern United States (Kuhn & Galloway, 2015); and Ontario (Kristofferson, 2006). Meanwhile, two studies were identified in Africa which are Nigeria (Igwe et al., 2018) and South Africa (Tselepis, 2018). Lastly , only one studies from Asia and Oceania which is Pakistan (Rashid & Ratten, 2021) and New Zealand (Stansfield et al., 2020).

The authors of selected articles employed qualitative and mixed method approaches. It was recorded that 87.5% of selected articles focused on qualitative analyses (Arias & Cruz, 2019; Bakas et al., 2019; Bislimi, 2022; Hill, 2021; Kristofferson, 2006; Kwiatkowski et al., 2021; Lindbergh & Schwartz, 2021; Marques et al., 2019; Ramadani et al., 2017; Rashid & Ratten, 2021; Solomon & Mathias, 2020; Stansfield et al., 2020; Teixeira & Ferreira, 2019; Tselepis, 2018). On the other hand, other studies employed mix method analyses (Igwe et al., 2018; Kuhn & Galloway, 2015). The qualitative method has gained popularity since it provides rich contextual information (Yin, 2016) that cannot be seized only from a quantitative and objective point of view (Ferreira et al., 2019). Some research questions cannot be answered using only quantitative methods (Busetto et al., 2020), thus the qualitative approach provides a more

compelling explanation of what is occurring (Henry and Foss, 2015).

Regarding the year of publication, the selected articles were published from 2006 to 2022. One article was published in 2006 (Kristofferson, 2006) followed by one article in each of the years 2015 (Kuhn & Galloway, 2015) and 2018 (Tselepis, 2018). In 2019, six articles were published (Arias & Cruz, 2019; Bakas et al., 2019; Igwe et al., 2018; Marques et al., 2019; Ramadani et al., 2017; Teixeira & Ferreira, 2019). In 2020, two articles have been published (Solomon & Mathias, 2020; Stansfield et al., 2020), followed by four articles in year 2021 (Hill, 2021; Kwiatkowski et al., 2021; Lindbergh & Schwartz, 2021; Rashid & Ratten, 2021) and one paper in 2020 (Bislimi, 2022).

This study also concentrated on the terminology and phrases utilised by previous researcher. The terms "artisan" and "entrepreneurship" are most frequently used, followed by "artisan entrepreneurship," "crafts," "creativity," and "family business" (see Figure 1). Huddle first introduced the phrase "artisan entrepreneur" in 1979 when researching the saving habits of a group of Colombian artisan entrepreneurs. However, in 2015, academics started showing interest in studying artisan entrepreneurship, and they still do today. This study developed a chronology of keywords from 46 papers, demonstrating how research on artisan entrepreneurship has broadened to include topics including tourism entrepreneurship, business growth logic, and entrepreneurial learning (see Figure 2).

Furthermore, the selected articles are published in 11 journals. Six articles were published in the International Journal of Entrepreneurial Behaviour and Research (Arias & Cruz, 2019; Bakas et al., 2019; Hill, 2021; Igwe et al., 2018; Marques et al., 2019; Ramadani et al., 2017). The remaining ten articles appeared in the following journals: Journal of Family Business Management (Bislimi, 2022), International Entrepreneurship and Management Journal (Rashid & Ratten, 2021), Journal of Policy Research in Tourism, Leisure and Events (Kwiatkowski et al., 2021), Journal of Business Venturing (Solomon & Mathias, 2020), Hospitality and Society (Stansfield et al., 2020), Journal of Enterprising Communities (Ferreira et al., 2019), Journal of Small Business and Enterprise Development (Lindbergh & Schwartz, 2021), Entrepreneurship: Theory and Practice (Kuhn & Galloway, 2015), International Journal of Fashion Design, Technology and Education (Tselepis, 2018) and Histoire Sociale (Kristofferson, 2006).

In addition, the journals that have been mentioned above had good quality as they were indexed by Scopus and Web of Science databases. There are twelve articles in quartile one (Q1) journals (Arias & Cruz, 2019; Bakas et al., 2019; Bislimi, 2022; Hill, 2021; Igwe et al., 2018; Kuhn & Galloway, 2015; Lindbergh & Schwartz, 2021; Marques et al., 2019; Ramadani et al., 2017; Rashid & Ratten, 2021; Solomon & Mathias, 2020; Tselepis, 2018), three articles in quartile two (Q2) journal (Ferreira et al., 2019; Kwiatkowski et al., 2021; Stansfield et al., 2020) and one article in quartile three (Q3) journal (Kristofferson, 2006).



Figure 1: The Keyword Analysis
Source: Authors

Figure 2: Keywords by previous scholars
Source: Authors

## Definition of Artisan Entrepreneurship

Previous scholars said that artisanal entrepreneurship was a new emerging trend in entrepreneurship (Ratten and Usmenji, 2022), and it was notably absent from the entrepreneurship literature (Ferreira et al., 2019). According to a survey of general trends in the literature, interest in artisan entrepreneurship has expanded dramatically since 2014, and a large number of high-quality journals have published important research in this area (Pret & Cogan, 2019). According to this study, the artisan entrepreneur has existed since the early industrialization of the year 1870 (Kristofferson, 2006). They previously used terminology like craftsmanship (Kristofferson, 2006; Lindbergh & Schwartz, 2021), crafts-people (Solomon & Mathias, 2020), artisan crafts (Rashid & Ratten, 2021), master-man, and journey-man (Kristofferson, 2006). The term "artisan entrepreneurship" has been found in literature since 1979 (Huddle, 1979), but it has received little attention from scholars until recently. As a result of the systematic literature review, it can be concluded that there are new trends in entrepreneurship, but the artisan entrepreneur is someone who has existed in entrepreneurship but under various names such as craftsman, food artisan, and beekeeper.

This study found a journey that started from an artisan to an artisan entrepreneur and finally as an artisan entrepreneur in the tourism sector (see table 2). The journey begins as a person uses their hobby to be an artisan (Hoyte, 2019; Kwiatkowski et al., 2021; Ramadani et al., 2017). Later, the growth opportunity leads them to become artisan entrepreneurs. However, the growth depends on the artisans. If they accept the growth, they will lose their artisan identity; if they reject the growth, the artisan identity is preserved (Solomon & Mathias, 2020). In addition, Kwiatkowski et al. (2019) also studied artisan entrepreneur growth and the findings indicated four types of responses

Table 2:  The significant attributes of three type of artisan

| Attributes | Artisan | Artisan Entrepreneur | Artisan Entrepreneur in Tourism |
|---|---|---|---|
| Growth | Reject Growth | Accept Growth | Accept Growth |
| Authentic | Yes | Mixed | Mixed |
| Commodification | No | Yes | Yes |
| Culture & Tradition | Yes | Yes | Yes |
| Creative | Yes | Yes | Yes |
| Innovative | No | Yes | Yes |

Source: Authors

to tensions between small-scale craftsmanship and business growth logic, which comprise of complying with small scale craftsmanship logic, combining or blending small scale craftsmanship logic with business growth logic, defying business growth logic, and compartmentalise business growth logic. In the context of artisanal entrepreneurs in tourism, the interest started in 2019. Seven studies identified discussed how artisan entrepreneurs contributed to the tourism sector through innovation, creativity, and culture (Arias & Cruz, 2019; Bakas et al., 2019; Ferreira et al., 2019; Kwiatkowski et al., 2021; Lindbergh & Schwartz, 2021; Marques et al., 2019; Stansfield et al., 2020). Therefore, the artisan journey depends on the values and opportunities for growth they gain. Whether the artisan accepts or rejects the growth, their passion, skills, and knowledge are valuable, especially in relation to culture and tradition.

The objective of this paper is to develop a comprehensive definition of artisan entrepreneurship.  Review from literature found that the definition of artisan entrepreneur remains ambiguous since the conception of artisan entrepreneurship is evolving [9] Therefore, this article adheres to [9] advice that future researchers focus on current definitions proposed by earlier academics. Based on our analysis, the artisan entrepreneur could be defined as:

Table 3: Definition Based on Type of Artisan

| Type of Artisan | Definition |
|---|---|
| Artisan | Artisan is a creative and talented individual who apply their skills, creativity, and passion to artisanal activities such as craftmanship, as well as food and beverage producers related to culture and tradition. |
| Artisan Entrepreneur | Artisan entrepreneur refers to a small business group of people who start a business with little or no financial means, use locally available materials, and choose family and close friends as employees. They maintain authenticity of product and generate revenue on a part-time or full-time basis. |
| Artisan Entrepreneur in Tourism | Artisanal entrepreneur in tourism was centred on artisanary, quality, localness, and authenticity of the product, which drew a lot of attention from a lot of tourist destinations that concentrated on creative tourism |

Source: Authors

## CONCLUSION

This study revealed that artisan entrepreneurs are competent individuals who use their passions, creativity, abilities, and expertise to develop a product or service in a limited quantity and offer it to customers (Ramadani et al., 2017). They produce artisanal products entirely by hand or with the use of hand tools or even mechanical methods (UNESCO, 1997), emphasising manual production over mass production, independence over conglomeration, local community over scale, and value creation over profit maximisation (Solomon & Mathias, 2020).

This study might be enhanced. In doing this research, the search string for this paper was merely "artisan entrepreneur." The authors seek to learn who is an artisan entrepreneur, also known as a craftsman entrepreneur (Bislimi, 2022), a culture or lifestyle entrepreneur (Ratten et al., 2019), an artisan entrepreneur from an industrial guild (Solomon & Mathias, 2020), and a food artisan entrepreneur (Lindbergh & Schwartz, 2021). In the future, the search string might be expanded to include more terms and phrases related to craftsmanship, creative tourism, food entrepreneurship, family business, and cultural heritage. These keywords are significant since they appear often in the 16 publications analysed in this study.

Overall, this study found that artisan entrepreneurship is about the journey of a person that started from an artisan to an artisan entrepreneur and finally as an artisan entrepreneur in the tourism sector. The journey begins as a hobby, and the growth opportunity leads them to become artisan entrepreneurs. The artisan remains true to its identity by rejecting growth and playing with authentic elements. On the other hand, those with an innovative way of thinking will continue to strive and inject elements of commodification and innovation into their thinking. Having clearly defined artisan entrepreneurs paves the way for more thoughtful policy choices and focused academic study.

## ACKNOWLEDGEMENT

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# MALAYSIAN'S SENTIMENTS ON SUICIDE-RELATED TWEETS DURING TRANSITION PHASE OF COVID-19

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## ABSTRACT

The transition phase of COVID-19 from pandemic to endemic has enlightened Malaysians about the crisis of mental health after the strict. Movement Control Order (MCO) was enacted. The transition phase is a phase where various sectors, such as schools, universities, and businesses, can re-operate and society granted their usual lives. This study aimed to further understand the context in which the keyword "suicide" was used by Malaysians on Twitter during the transition period. "Suicide" is the keyword used in order to mine the data with the Ncapture plugin from Nvivo 12. Also, by using the same software, content análisis has been conducted to identify the theme of tweets tweeted by society. The tweet content was then analyzed using VADER sentiment analysis to determine if it was positive, neutral, or negative. The content análisis showed five (5) different themes: i) criticsm of the government on that day, ii) mental health awareness, iii) suicide experiences, iv) suicide rants, and v) suicidal thoughts. Positive and negative sentiments, both can be displayed from the word "suicide" itself. Positive tweets conveyed hope and support to those who suffered from rebuilding their lives after the pandemic. While, negative tweets expressed disappointment and anger with the government's action on how they handled the situation in both social and economic impacts, and how their usual data as a médium to understand society's behaviour through a virtual platform in an unparalleled situation. This study also attempts to demonstrate the time and cost-effectiveness of social media data análisis for valuable insights into public opinión and attitudes towards specific topics.

*Keywords : geospatial, suicide, data mining, sentiment análisis, content analysis*

# INTRODUCTION

Various precautions were taken during the outbreaks of coronavirus disease in 2019, or its abbreviated name, COVID-19. Categorized under the SARS infection, this disease shows fast transmissibility from human to human through direct contact, respiratory droplets, and respiratory secretion, along with commonly occurring symptoms such as fever, dry cough, headache, fatigue, and shortness of breath (Okolafor et al., 2021). Preventions such as the total shutdown of businesses, companies, schools, universities, and movement restrictions on travel (Okolafor et al., 2021) have caused massive reactions from Malaysians after the country was officially announced for the first lockdown phase in March 2020 (Rahim & Iqbal, 2020). Became the turning point of a big part of human lives, the new norm of daily life had to be adapted. Social distancing, the mandatory wearing of face masks, especially in enclosed spaces, sanitizing hands, and scanning for admission to any areas have been conducted for the past two (2) years. Thus, some parts of disease precaution are still in practise as the new norm.

The transition phase of COVID-19 in Malaysia started on 1st April 2022 after almost two (2) years in the pandemic phase. The pandemic phase was enacted after the government observed the readiness of Malaysians to cope with the disease by implementing strict standard operating procedures (SOPs) such as the mask mandate (The Malaysian Reserve, 2022). The successful COVID-19 vaccination programme and high rate of vaccination among Malaysians were the major factors in the transition to the endemic phase (Ministry of Health, 2022). Thus, this brings about changes to the daily routine updates on social media, which also include the suicide news that was daily updated before the transition.

As the majority of Malaysians were using their social media due to high internet access penetration (DataReportal, 2023), this behaviour is not changing despite the transition period, as they were already adapted to the news being posted online, and discussions and social interaction were made virtually using various not-so-new features of video calling such as Google Meet, Cisco Webex, and Zoom. Twitter is the most popular platform among the younger generations, followed by Facebook. Mental health and suicide were two of the most discussed topics on the online platform. A study conducted by Rusli et al. (2023) mentioned that "suicide" manifests frustration, emotion, and public anger due to disappoinment and the effects of COVID-19 on their lives. Despite the negativity, "suicide" also presented a positive message by sending positivity and understanding about the struggle of overcoming mental health issues. Plus, social media became another platform to deliver messages, awareness, and ideas of mental health promotion (Mat Ruzlin et al., 2021).

Figure 1 shows the statistics of COVID-19 new cases, deaths, and vaccination rate compared to the number of news stories related to mental health, suicide, and depression. It shows that the number of news stories on depression, mental health, and suicide spiked the highest in May 2022, with 26 news, 34 news, and 17 news, respectively, despite the fact that four different phases of the recovery plan were enacted.
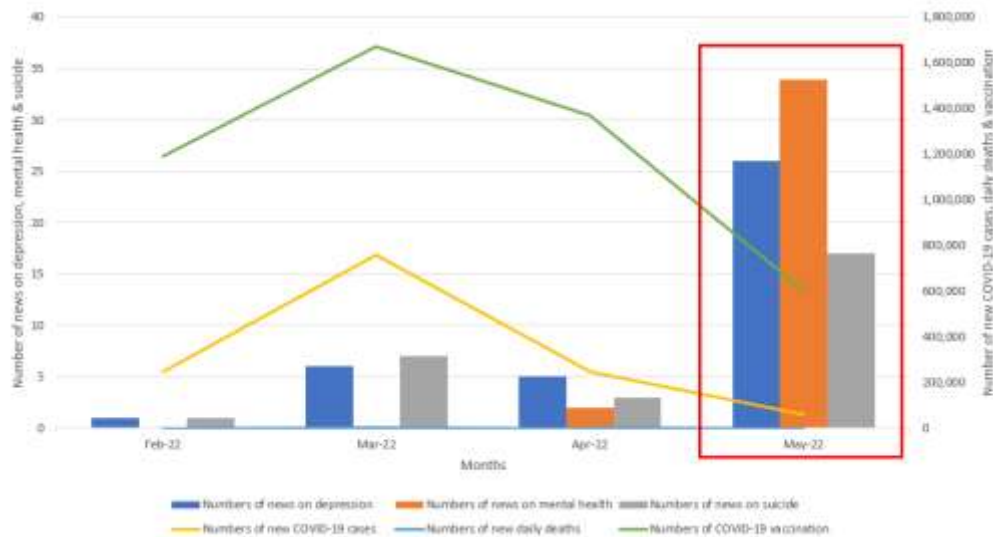
**Figure 1** Statistics of COVID-19 new cases, deaths, & vaccination rate compared to number of news related to mental health, suicide, and depression
Note: The number of COVID-19 cases, deaths & vaccination rate data were obtained from the Ministry of Health. While number of news related to mental health, suicide, & depression were collected by using the data mining technique.

## METHODOLOGY

Social media big data mining is the process of collecting data from social media platforms. This study used Twitter as a platform to mine data by mentioning the keyword "suicide" in any tweets. Malaysia, both Peninsular Malaysia and Borneo were chosen as the study áreas with a population of over 32.7 million. Ncapture is a non-paid web browser extensión that allows you to collect various types of content, such as articles, Twitter, and Facebook. It also allows you to capture, extract, and mine the spatial location of the tweet posted.

As mentioned, the transition period started on 1st April 2022, and the timeline chosen is from 20th February until 31st May 2022. However, Ncapture only managed to collect data from 9th May to 13th May 2022. We also used "bunuh diri" (English: suicide) as Malaysia's national language is Malay in order to focus on larger scale of tweets. Thus, the data collected is in both Malay and English. This study also conducted the same method as (Rusli et al., 2023).

The data collected involved pre-processing by removing usernames, hashtags, lower-case letters, punctuation, and stop words. Then, the Google Collab platform was used to create a text-filtering Python programme to incorpórate the Natural Language Toolkit (NLTK). Valence Aware Dictionary and Sentiment Reasoner (VADER) was also used in order to analyze the sentiment expressed through text in social media. VADER is a rule-based sentiment análisis tool and a lexicón used to examine sentiments on social media.

## MAIN RESULTS

### Theme of "Suicide"-related Posts

The data collected identified the factors of "suicide"-related posts before the sentiment of Malaysians on "suicide"-related posts was calculated. The keyword suicide has collected 6,062 data nationally. "Suicide"-related issues are the most expressed and posted during the transition phase. Figure 2 shows the percentage of five (5) contents: i) critics to the government of the day (GOTD), ii) rant, iii) suicidal thoughts, iv) suicide awareness

and support, and v) suicide experience.

Suicide experience has the highest percentage with 88.11%, as there was one repeated posting (or re-posting numerous times) of a suicide attempt of their closest friend caused by love life, which ended in psychiatrist treatment. Even though it does not mention the viral disease, it does contribute to the fact that highest percentage due to the posting was posted during the transition period stated.

Not only that, critics to the GOTD received

4.11%, as people in this transition phase had already returned and focused on their daily routines after businesses, schools, universities, and other sectors had been reopened.

Table 1 shows a table of the theme of discussion, a short description, and examples from the collected postings. As shown, ranting is also included. The rant is about how our society returned to their daily lives and shared their stories or rant on how their daily routine affected them.
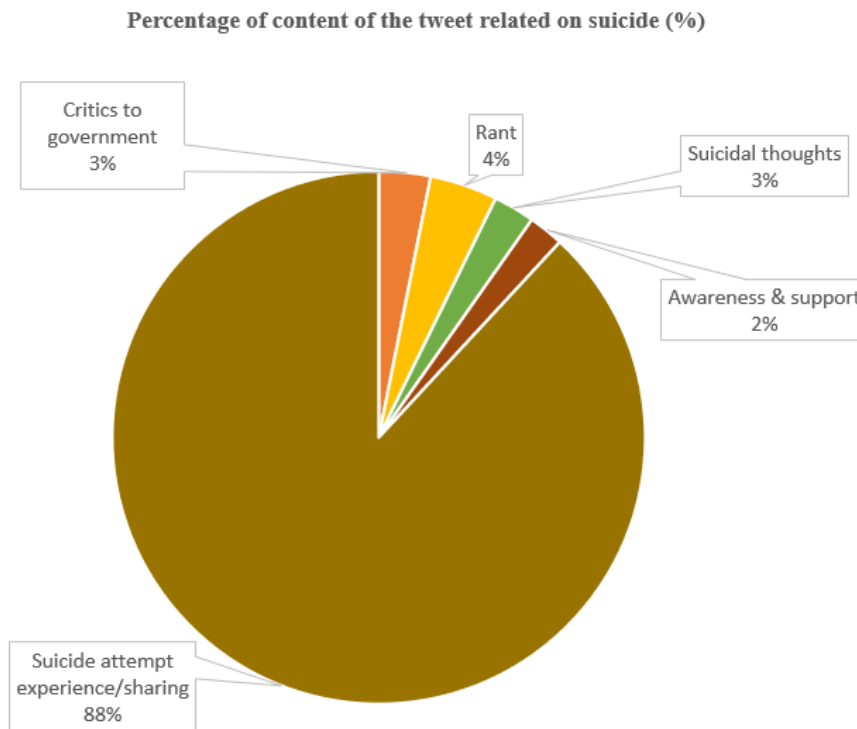


**Figure 2** Percentage of 5 themes of "suicide"-related content in Twitter

**Table 1** Theme of discussion and examples

| Theme of Discussion | Description | Example of postings |
|---|---|---|
| Suicide attempt experience/sharing<br><br>Total: 88% | Other's experience | "Poor my friend. She broke up with her boyfriend at the age of 28, and she had to make an appointment with the psychiatrist. Attempted suicide numerous times. She lost her career in the middle of her pursuing her master's degree. Because, as you know, when a heart breaks, it does not break even. It was always one side that had to suffer a lot." |

| | | "There was another friend who got diagnosed with VSS due to being over-stressed because he was very committed to his job, and one of his seniors and the high performance of the company's staff were too good that it made him feel like attempting suicide. But now, he said, "Happiness is what we have to decide. Enough or not, that is what we have decided." |
|---|---|---|
| Suicide thoughts<br><br>Total: 3% | Feeling depressed | "Is committing suicide the only way?" |
| | | "When your depression comes, it makes you want to commit suicide" |
| | | "If committing suicide is something accepted, I've already done it. I'm so tired." |
| | | "It was the most **** day, and I wanted to commit suicide." |
| | | "I really wanted to commit suicide" |
| Critics to the government on the day (GOTD)<br><br>Total: 3% | Criticsm to the government | "If society is the King, we are not living in the muddy area, red bausit dust, anxiety feeling when it's raining in KL, having to always take a look at the parking lot, jumping from high buildings to commit suicide during MCO, stealing a tin of sardine and baby diapers, drinking muddy wáter, and crossing the embankment to work in another country." |
| | | "The opposition party that wanted to become the government will also be the bandit. What happened to LGE's case? The witness even committed suicide." |

### Sentiment on "Suicide"-related Tweets

During the transition phase to endemic, the number of postings on Twitter has decreased. This is caused by the important sectors such as schools, businesses, corporate companies, industries, and universities that have opened in order to recover the nation's economy. Plus, our society has to adjust to their new norm in their daily routines. Thus, there were still some times when people would still post something related to the viral disease COVID-19 and their daily routines. Figure 3 shows the statistics of the number of tweets/retweets hourly from 9th May at 3:00pm and ended at 13th May 2022 at 12:00pm.
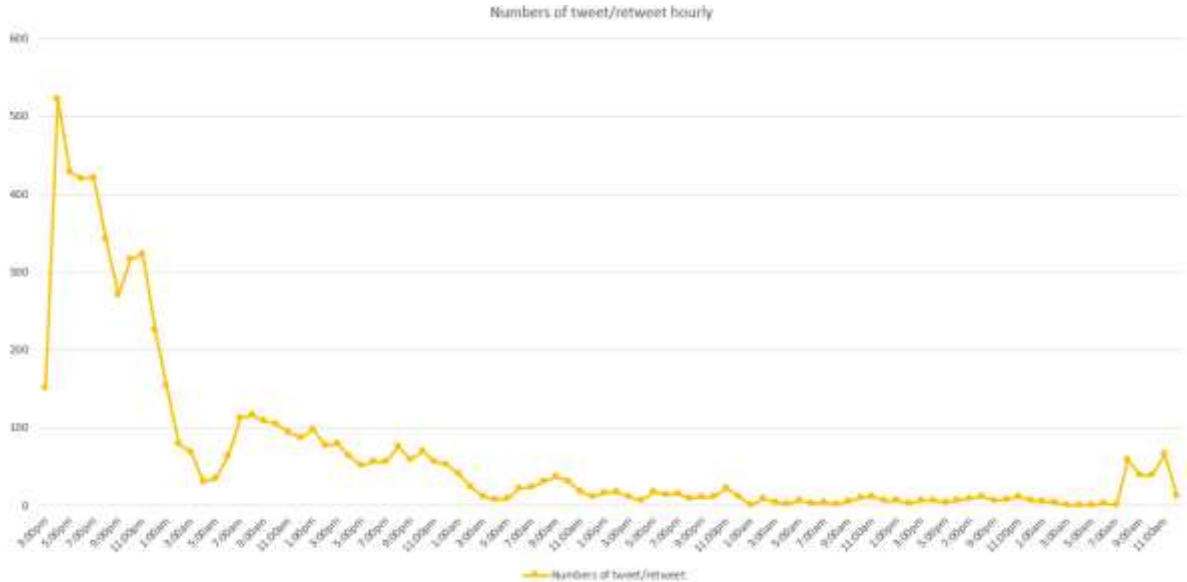
**Figure 3** Number of tweet/retweet hourly from 9<sup>th</sup> May until 13<sup>th</sup> May 2022

The tweeps can be observed actively at 5:00pm on 9th May during daylight with over 500 posts, and during nighttime between 9:00pm and 11:00pm over 300 posts. While there were no high differences between the rest of the date stated, with below 100 posts were posted.

The timing of the tweets posted can be explained by using the sentiment score graph in Figure 4 from the date of 9th May until 13th May 2022. The graph uses range of positive (compound ≥ 0.05), neutral (compound > -0.05, and compound < 0.05), and negative (compound ≤ -0.05). The percentage of positive, neutral, and negative sentiment can be determined by counting the number of tweets per day in each category, and dividing it by the total number of tweets, and then multiplying by 100. Figure 4 shows the sentiment value of the tweets along with the percentage for each sentiment.

Percentage of Twitter Average Sentiment Score (%)
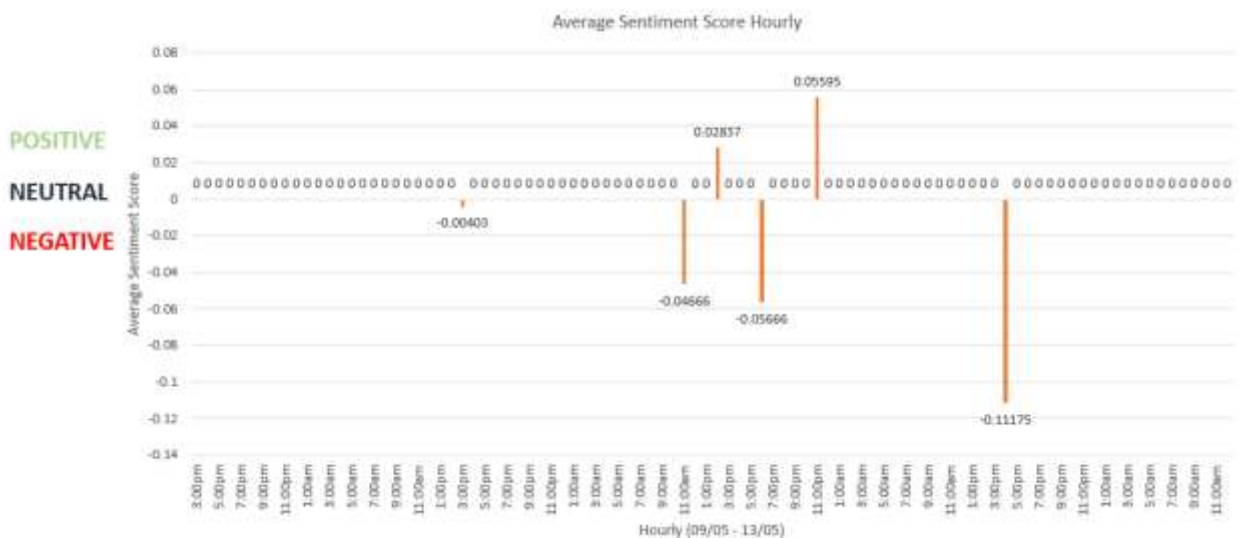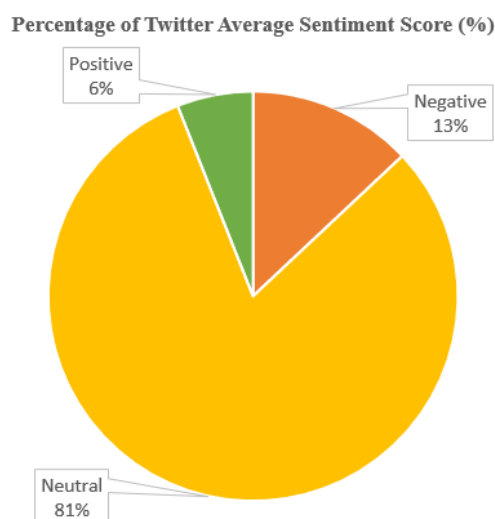


**Figure 4** The sentiment value and percentage of tweets posted from 9ᵗʰ May until 13ᵗʰ May 2022

Despite the high number of tweets recorded within the time frame stated, there were only six (6) hours within which the postings were able to be valued for sentiment value. A negative average sentiment value was recorded in the time range of 3:00pm to 6:00pm with a score of -0.00403, 9:00am to 12:00pm (-0.04666), 6:00pm (-0.05666), and 3:00pm to 6:00pm (-0.11175).

There were only two (2) time ranges that were able to calculate the average sentiment value, which were between 12:00pm to 3:00pm (0.02837) and 9:00pm to 12:00am (0.05595). In short, based on Figure 3, the highest positive average sentiment value is in the time range of 9:00pm and 12:00am (0.05595) and the highest negative average sentiment value in the time range is at 6:00pm (-0.05666).

As mentioned earlier, a tweet from a user sharing their friend's experience committing suicide due to relationship failure does contribute to the high percentage of negative average sentiment value. Although it is not related to any COVID-19 cases or daily rants on routines, it is still considered under the mental health category as human wellbeing is mentioned.

## DISCUSSION

Suicide is a taboo topic to be discuss among our society. This is because of people oversee this act as a sinful act and giving bad influence to the others especially during the critical and hard times. Awareness on suicide and relating it to mental health always become a center of discussion during critical times as people are facing hardships such as financial struggles and social.

Sharing their problems and gaining mental health awareness through social media platform are the easiest way to reach engagement between the public. This is due to people in this modern era has been exposed to the world of virtual news and virtual social interaction, which everything is very easy to access. However, despite the huge awareness campaign and effort to educate people on knowledge, we cannot deny people's negative sentiment. Despite the enormous education and positivity spread, it also hard to find comfort in negative sentiment. It brings so much impacts to those who affected by it. That become the reason of people avoiding to share their mental health related journey to the public.

In another hand, government's action in handling critical situation also become

one of contributors to people's health. The mitigation, enactment of standard of procedures (SOPs) conducted by the government also need to be efficient. In the case of COVID-19, our society were criticizing on how inefficient and messy SOPs announced and conducted by the government. This leds to people being disappointed and at the end, it does effecting people's lives.

## CONCLUSION

As this study aimed to further understand the mental health context in which the keyword "suicide" was used by Malaysians on Twitter during the transition period, there are significant conclusions from our findings.

First, the data collected from Twitter revealed five (5) different themes: i) suicide attempt experiences or sharing, ii) critics to the GOTD, iii) rants, iv) suicidal thoughts, and v) awareness and support.

The transition phase from pandemic to endemic has impacted human daily lives for the past two (2) years since the first pandemic hit on 18th March 2020. Various prevention, pre-cautionary steps, and recovery plans were enacted in order to rebound the nation's economy and social life, as well as protect Malaysians from the viral disease. Even though the transition phase brings new norms into human daily lives, such as the mask mandate and hand sanitizing, it also brings mental health awareness to our society. People are becoming more aware of mental health and concern through the word "suicide" being repeatedly mentioned in the news and among their friends and people them. They also try to understand each other's struggles and give their support through positive messages, despite the word "suicide" being mentioned.

Criticism of the government is an act of response to the government's handling the chaotic and messy recovery plan and the transition phase as they impact society's lives and the nation's economy. By mentioning the number of cases daily and situations that worsen from time to time due to the lockdown, society is in high concern and expects the government to do better for them.

After the re-opening of businesses in the industrial, school, and university sectors, people were back to share their daily routines, such as struggling to re-maintain their focus on work physically after being a long time doing work virtually. Society also expresses their thoughts as well as spreading mental health awareness and support by conveying positive messages and actions.

In short, this study focuses on the Malaysian context and the transition period regarding "suicide"-related tweets. It provides insights into Malaysians' attitudes and sentiments towards the word "suicide" during the transition period. The themes help us to discover a better perspective on Malaysians' responses, challenges, and rants after the sectors re-opened. By highlighting the local context when analyzing social media data, it is important to understand the potential of social media big data in understanding behaviour and attitudes virtually.

## ACKNOWLEDGEMENT

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# EXAMINING THE IMPACTS OF ONLINE BOOKING SERVICES ON SMALL-SCALE TOURISM ACCOMMODATION

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## ABSTRACT

This study will look into the effects of online booking services, including the use of social media platforms, on small-scale accommodation businesses in island destinations. This research looks at the challenges and opportunities that these businesses face in the context of tourism planning and development. A qualitative research method was employed by conducting semi-structured interviews with small-scale tourism accommodation operators and visitors, in addition to content analysis of the past studies. The study starts with an examination of the present conditions of online reservations, the types of offerings available, and how they are utilised by online platform users, particularly tourism accommodation business operators. According to the findings, the online platform makes it easier for operators to keep track of room bookings, reduces labour costs, and allows providers to connect with a larger customer base. Visitors benefit from the same benefits because the online platform makes it easier for them to plan their journey ahead of time. However, there are flaws in online booking services, such as security risks, limited real-time communication between suppliers of accommodations and consumers, poor customer service, undependable technology, and price inconsistencies. This study takes an in-depth look at the industry's approaches to maximising internet-based reservation performance along with the way they modify the ways they operate to satisfy the demands of consumers. Finally, practical solutions have been suggested to improve the sustainability of their tourism accommodation business and to contribute to the tourism industry in general. The outcomes of this study will contribute to the existing body of knowledge on the impacts of online booking services in the context of small-scale tourism accommodation and offer valuable insights for industry stakeholders and policymakers to further support this sector's development in Malaysia.

*Keywords : online reservation , small-scale accommodation, business sustainability, smart tourism*

## INTRODUCTION

Small-scale accommodation is barely distinguished from the medium-scale accommodation. As cited in Quah W.B. & Chan J.K.L. (2008), most of the past research has only combined the small and medium-size accommodation (SMSA), yet Ingram et. Al (2000) did set a limit of 50-

rooms operating hotel as the small-scale. However, the small-scale tourism accommodations are more significant and contributes more to European market compared to the large one (Bastakis et. Al., 2004). These small-scale accommodations are also always the one that cater the needs for the rural tourism industry (Fredricsson C. & Smas L., 2013). In Malaysia on the other hands, the small-scale tourism accommodations are largely dominated by the guest house which mostly using the name "homestay" and the new trend of daily room rental known as "roomstay." Various types of guest house are being offered in Malaysia, ranging from a simple budget-friendly house or room rental to luxurious villas. These kinds of small-scale accommodations can mostly be found in rural or suburban area as there are limited physical development being done and the population is not as dense as in the urban or metropolitan area, which hence there are limited accommodation supply available. As the government recognized the potential of small-scale accommodations, several initiatives have been implemented and introduced to support and promote the sector.

The rise of online booking services including the social media platform have made it much more easier for the small-scale tourism accommodation operators to promote their products and services. The technology growth not only has provided them the opportunity to showcase their properties and unique features of their services, but it also allows them to connect with broader audience which can be their potential guests, and directly engage with them. However, such newly-introduced marketing platform may also bring harm towards the users, including the accommodation operators as well as the tourists, especially in term of information security.

## MAIN RESULTS

### Present Conditions of Online Booking

The travel and tourism industry, including online booking, has been significantly impacted by the COVID-19 pandemic. Travel restrictions, lockdowns, and safety concerns led to a decline in bookings (Buharova I. & Vereshchagina L., 2021). However, as vaccination efforts progress and travel restrictions ease, there has been a gradual recovery and an uptick in travel bookings. Due to ongoing travel restrictions and cautious traveler sentiments, there has been a notable shift towards domestic travel. Online booking platforms have witnessed increased demand for domestic accommodations as travelers explore local destinations. This trend is likely to continue until international travel fully resumes. The pandemic has heightened the focus on health and safety in the travel industry. Online booking platforms have adapted their services to include features highlighting hygiene protocols, cleanliness standards, and flexible cancellation policies. Travelers are now prioritizing accommodations with clear health and safety measures. Contactless experiences and digital solutions have gained prominence. Online booking platforms are increasingly providing options for self-check-ins, digital key access, and contactless payments to minimize physical interaction. Accommodation providers are leveraging technology to offer a more seamless and secure booking process. In response to the uncertainty created by the pandemic, online booking platforms have revised their policies to offer more flexibility and better cancellation/refund options. This provides travelers with reassurance and greater confidence in making bookings.

Online booking platforms are continuously evolving to utilize emerging technologies. This includes incorporating artificial intelligence (AI) and machine learning to enhance search and recommendation algorithms, personalized travel experiences, and dynamic pricing strategies. Virtual reality (VR) and augmented reality (AR) are also being used to offer virtual property tours and immersive experiences. As there is a growing emphasis on sustainable and eco-friendly travel, online booking platforms are increasingly providing options for eco-certified accommodations and promoting sustainable tourism

practices. Travelers are showing increasing interest in accommodations that prioritize environmental conservation and contribute to local communities. The online booking sector remains highly competitive, with various platforms vying for market share. Larger players continue to expand their services and acquire smaller competitors, leading to consolidation within the industry.

a) **Types of Offerings Available**
Online booking services in Malaysia provide a wide range of offerings to cater to various traveler preferences and budget ranges. From hotels and resorts to homestays and apartments, travelers can easily find and book accommodations that suit their travel needs and preferences through these online platforms. The availability of diverse options ensures that there is something for every type of traveler visiting Malaysia.

i. *Homestays*. Homestays are popular among tourists who seek a more local and authentic experience. They are typically operated by local families who rent out a part of their home or a separate unit to visitors. Homestays offer personalized services, allowing tourists to immerse themselves in the local culture and lifestyle.

ii. *Guest houses*. Guesthouses are small-scale accommodations that provide basic lodging facilities. They typically offer private rooms or shared dormitories, catering to budget-conscious travellers. Guesthouses are often managed by the owners themselves, creating a more personal and intimate atmosphere for guests.

iii. *Boutique Hotels*. Boutique hotels in Malaysia are known for their unique designs and personalized services. These small-scale accommodations provide a blend of luxury and individuality, offering guests a unique experience. Boutique hotels often cater to niche markets, such as eco-tourism or heritage tourism, providing specialized services and amenities.

iv. *Eco-lodges*. With the growing interest in sustainable tourism, eco-lodges have gained popularity in Malaysia. These accommodations are built with a focus on environmental conservation and integration with nature. Eco-lodges often offer activities such as nature hikes, wildlife spotting, and sustainable practices, attracting eco-conscious tourists.

v. *Agrotourism accommodation*. As Malaysia is an agricultural country, agrotourism accommodations have emerged as a specific type of offering. These accommodations are typically located on functioning farms or agricultural estates, allowing visitors to experience rural life and participate in farming activities. Agrotourism accommodations often provide unique experiences such as fruit-picking, fishing, or animal feeding.

b) **The Platforms for Online Booking Services in Malaysia**
Online travel agencies (OTA) have been widely used for the reservations of tourist accommodation all over the world. Besides, social media platforms also play a significant role in promoting and booking small-scale tourism accommodations in Malaysia. Some of them may not be dedicated online booking platforms, yet they serve as effective marketing and communication channels for small-scale accommodation providers. Here are some online platforms commonly utilized in Malaysia:

i. *Airbnb*. Airbnb is a widely used platform for booking accommodations, including small-scale tourism accommodation options such as homestays, guesthouses, and apartments. It allows property owners to list their spaces, and travellers can book directly through the platform.

ii. *Booking.com*. This is a global online booking platform that offers a wide range of accommodations in Malaysia, including small-scale options. It features hotels, resorts, guesthouses, and other types of accommodations, providing a convenient

booking process for travellers.

*iii. Agoda*. Agoda is another popular online booking platform that features a wide range of accommodations in Malaysia. It offers not only hotels but also smaller-scale accommodations like guesthouses and homestays, catering to different travel preferences including for long stay purposes.

*iv. Traveloka.* This website and application is a Southeast Asian online travel platform that covers various travel services, including accommodation bookings. It provides a selection of accommodations in Malaysia, including small-scale options, and offers competitive pricing and deals.

*v. Expedia*. Expedia is a global travel booking platform that allows users to search and book accommodations in Malaysia. While it primarily focuses on hotels, it also includes small-scale options such as guesthouses and bed and breakfast establishments.

*vi. Facebook*. Facebook is widely used by small-scale accommodation providers to showcase their properties and interact with potential guests. They can create Facebook pages or groups to share information, photos, and updates about their accommodations. Communication and booking inquiries can be managed via private messages or comments.

*vii. Instagram*. Instagram is highly visual and allows small-scale accommodation providers to share enticing photos and stories about their properties. Through Instagram, owners can enhance their online presence and engage with potential guests. They can include contact details or direct potential guests to their booking platforms or websites for reservations.

*viii. Twitter*. While Twitter is primarily a micro-blogging platform, small-scale accommodation providers can utilize it to share quick updates, promotions, and announcements. It provides a platform for direct interaction with potential guests,

answering inquiries, and directing them to booking platforms or official websites.

*ix. Whatsapp*. This apps is a popular messaging platform, is often used as a communication channel for small-scale tourism accommodation providers in Malaysia. While it may not function as a dedicated booking platform, WhatsApp enables direct and real-time communication between accommodation owners and potential guests.

## Challenges and Opportunities of Online Booking Services for Small-Scale Accommodation

The effects of online booking services on small-scale tourism accommodations in Malaysia can be both positive and transformative. By understanding and addressing the challenges while leveraging the opportunities presented by online booking services, small-scale tourism accommodations in Malaysia can enhance their business operations, expand their reach, and attract more guests for sustained growth of the tourism accommodation operation.

a) **Challenges of Online Booking Services**
The small-scale tourism accommodations face challenges where they tend to miss out on the new technologies' adaptation and management (Quah W.B. & Chan J.K.L., 2008). In general, the management for small-scale tourism accommodation does not even signify the up-skill training of their workforce (Ingram et. Al, 2000). Small-scale accommodations in rural areas face more challenges in term of the promotion when the online booking services are not being fully utilized (Fredricsson C. & Smas L., 2013).

*i. Market Competition*. The online booking sector is highly competitive, making it challenging for small-scale accommodation providers to stand out among larger hotels and resorts. Limited marketing budgets and resources can make it difficult to compete for visibility and

bookings.

*ii. Technological Barriers.* Some small-scale accommodation providers may face challenges in adopting and managing online booking systems due to limited technological know-how or access to technology. This can hinder their ability to effectively leverage online platforms for bookings.

*iii. Cost and Commission Structures.* Online booking platforms often charge commissions or fees for each booking, which can reduce profit margins for small-scale accommodations. The cost of participating in online booking services may be a significant concern for smaller businesses with limited budgets.

*iv. Customer Reviews and Ratings.* Online reviews and ratings have a significant impact on travellers' decision-making processes. Small-scale accommodations may face challenges in garnering enough reviews and managing negative feedback, potentially affecting their online reputation and bookings.

*v. Risk of Scam and Tech Crime.* Some of the small-scale accommodation operators use the social media platform which has less tech security. This might lead to a disadvantage on both operators and travellers as some might be taking the opportunity to fake the booking information or steal the data.

*vi. Booking Overlap.* This happened when the operators utilize more than one online booking platforms, and the reservations might overlap with one another. Other case might also happen in the same online platform when there is limited room available, and more guests are making the reservations at the same time.

b) **Benefits of Online Booking Services**
As mentioned by most of the past research, online booking services provide opportunity for greater visibility to broader audience no matter how far their distance is. Such exposure allows the small-scale tourism accommodations to be discovered by the potential guests that might have never been aware of their existence in the past. This hence will lead to more advantages for the small-scale tourist accommodation.

*i. Increased Visibility and Reach.* Online booking services provide small-scale accommodations with the opportunity to reach a broader audience and gain exposure beyond traditional local marketing efforts. It allows them to tap into domestic and international markets, potentially attracting more guests.

*ii. Direct Booking Relationships.* With online booking platforms, small-scale accommodation providers can establish direct relationships with guests. By offering personalized communication and tailored services, they can enhance the overall guest experience and foster guest loyalty.

*iii. Flexibility and Dynamic Pricing.* Online booking platforms enable small-scale accommodations to apply flexible pricing strategies, adjusting rates based on demand and occupancy. This flexibility can help them optimize revenue and attract guests during low-demand periods.

*iv. Access to Analytics and Insights.* Online booking platforms often provide valuable analytics and data insights to accommodation providers. These insights help small-scale businesses to better understand guest preferences, booking patterns, and market trends, allowing them to make data-driven decisions and improve their offerings.

*v. Partnership Opportunities.* Online booking platforms may facilitate partnerships or collaborations with other businesses in the tourism industry. This could help small-scale accommodations tap into new markets, enhance guest experiences through tour packages or provide cross-promotion opportunities.

*vi. Enhanced Operational Efficiency.* Online booking platforms offer features that streamline processes such as availability management, reservations,

and guest communications. By leveraging these tools, small-scale accommodations can improve operational efficiency and provide a seamless booking experience.
*vii.   Sustainability Promotion*. Online booking platforms often highlight sustainable and eco-friendly accommodations. This provides an opportunity for small-scale accommodations with sustainable practices to gain visibility among environmentally conscious travellers.

## CONCLUSION

Overall, the impact of online booking services on small-scale tourism accommodation in Malaysia has been largely positive. It has opened up opportunities, improved revenue, and enhanced visibility. However, owners need to adapt to the changing landscape, manage competition effectively, and leverage online platforms to their advantage to ensure continued success. The social media platforms also provide small-scale accommodation providers with an opportunity to reach a wider audience, engage with potential guests, and communicate directly for bookings and inquiries. While bookings are generally redirected to dedicated online booking platforms or websites, social media can still serve as an effective marketing tool and customer engagement platform for small-scale tourism accommodations in Malaysia.

The availability of online booking services has significantly influenced the small-scale tourism accommodation sector in Malaysia. This study has provided valuable insights into the different types of offerings available and how they have been impacted by online booking platforms. By examining these impacts, the research has contributed to a better understanding of the challenges and opportunities faced by small-scale accommodations in an increasingly digitalized tourism industry.

However, for small-scale accommodation operators, more training needs to be provided to increase their technology skills and awareness so as to let them catch up with the advancement of the large accommodation providers. Financial support may also be provided such as in terms of government incentives to assist them with the utilization of online booking platforms services payment.

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# REVIEW ON REQUIREMENTS AND PROCESS OF SOCIAL IMPACT ASSESSMENT FOR PROJECT DEVELOPMENT IN MALAYSIA

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## ABSTRACT

The proposal of new development is always aligned with the well-being of social life, the effectiveness of economic development, and the preservation of the future environment. The Social Impact Assessment (SIA) is a social science study focusing on the impact of social and economic systems closely related to industrial physical development, land use, and environmental change. SIA is a requirement that should be implemented in the proposal as it considers the views of human necessities, concerns, and needs of the development. This paper aims to review the requirements and process of SIA within the project development that fulfills the social needs and the impacts of the project development. The qualitative method, content analysis, was adopted using references from books, articles, and development reports. The objective of this study is (1) to identify the requirements to be implemented in the preparation of the SIA report in the development of the project and (2) to review the involvement of local authorities in the SIA reporting process. Implementing the SIA process is seen as a social tool that assists in the development planning process, which effectively addresses social issues in the local area.

*Keywords : requirements; process; Social Impact Assessment (SIA); project development; review*

## INTRODUCTION

Social Impact Assessment (SIA) is a social science study focusing on the impact of social and economic systems closely related to industrial development, land use, and environmental change. Changes due to the development planning that develop over time affect not only the economy and the environment but also the changes in the daily life of the local society (Hassan, 2018).

This effect is likely to positively and negatively impact three main aspects, namely social, economic, and environmental, whether intentional or unintentional. According to the International Association for Impact Assessment (IAIA), Social Impact Assessment (SIA), also known as social impact assessment studies, is one of the impact assessment studies that focuses on assessing social changes that occur

due to development around human, local, and community areas.

SIA received the first recognition in state legislation in the NEPA in 1969, and its institutionalization has gone through a lengthy process. Most countries and international donor organizations have adopted SIA requirements in national law or agency policy as part of EIA requirements. Developers in the private and public sectors worldwide are increasingly aware of the benefits of SIA and EIA. Such recognition, at least, is partly forced due to project failures resulting from insufficient assessment of projects on narrow economic and technical criteria (Rickson et al., 1990; Burdge, 1998).

According to (Vanclay & Franks, 2015), the SIA process involves many tasks related to the development phase and framework. SIA indirectly has an association with EIA, another picture of the social system in environmental management by focusing on the continuous improvement process of the environment.

**Table 1** History of Social Impact Assessment (SIA) in Malaysia

| Year | Description |
| --- | --- |
| 1990s | Throughout the introduction of the *National Social Policy, the government has initiated discussions on social issues and the need for a national social policy. <br> **National Social Policy is a policy or policy for social development based on good values and improving human potential in achieving unity and social balance, national resilience, and the well-being of a progressive and robust Malaysian society.* |
| 1996 | National Social Policy establishes Cabinet Committee to prevent social issues (KJMMS) |
| 1998 | SIA introduced to Cabinet Committee |
| 2001 | In the SIA study, one study was conducted with *Taylor Baines & Associates with eight local consultants for eight months. **Taylor Baines & Associates is an independent research provider and consulting firm that works primarily in the field of assessment, policy, and management of social and nature research.* |
| 2002 | SIA Malaysia Handbook by the United Nations Women, Family & Community Development and Development Programme. |
| 2012 | Manual for the Preparation of Social Impact Assessment (SIA) Report for Development Projects by PLAN Malaysia and *Malaysia Social Impact Assessment (MSIA). **MSIA is an association of professional members involved in SIA. The association was formally approved by the Registrar of Societies in 2005. Since then, the Annual General Meeting has been held every two years.* |
| 2017 | Manual for the Preparation of Social Impact Assessment Report (SIA) for 2nd Edition Development Projects by PLAN Malaysia |

Source: A Review of SIA Procedure in Malaysia, 2018

The need for using SIA has also been prepared as a Manual for the Preparation of Social Impact Assessment Report (SIA) for Development Projects by PLAN Malaysia. This manual serves as a guide in preparing the understanding and preparation requirements of SIA involving development projects for the benefit of the state, state, and district levels. Under Subsection 20B (1) &(2) gazette to replace subsection 21A (1)(ea) throughout the Law of Malaysia A 1522. Subsection 21A (1) (ea) states that "analysis of mitigation measures for social impact and other effects as determined by local planning authorities," and subsection (1A) has been eliminated.

Comprehension of Burdge from the Benefiting from The Practice of Social Impact Assessment (2012), there is a statement that this approach is essential in getting a perspective angle from the community after most of the development is only concerned with the environment. If viewed at the development proposal stage, the development needs should consider the advantages to the people and

the local community. Community groups focusing on understanding the concept of SIA processes in development make SIA a tool that helps reduce the impact on local society.

The preparation of the SIA process in terms of procedures and criteria is unknown to the public, i.e., the public and the community for evaluating the SIA report. The application of the SIA assessment report in terms of measures and mitigation provided is to reduce the impact of development planning on the public. Local authorities are the bodies that are aware of the SIA assessment process as well as the development planning process as stipulated in the Town and Country Planning Act 1976 (Act 172). Section 6 (1)(b) states the duties of local authorities such as (b) to undertake, assist, and promote the collection, maintenance, and broadcasting of statistics, newsletters, monographs, and other broadcasting relating to urban and rural planning and its methods. The procedure for SIA's involvement in development planning is an impact that affects the public directly and needs to be informed for compliance with the assessment of the SIA report.

The definition of impact is seen in terms of positive or negative impact, intentionally or unintentionally. This definition measures the impact of identifying and measuring a change. From a psychological point of view, this theory expressed by Bibb Latanē (1981) explains how a source of issue affects the target group. It states that the amount of influence a person experiences in a group depends on (i) the strength (power or social status) of the group, (ii) the proximity (physical or psychological) of the group or the urgency factor, and (iii) the number of members in the group that generates influence (i.e., the equivalent of the number of sources of influence).

The legal mandate for SIA in Malaysia has also been expanded through amendments to the Town and Country Planning Act and how the Department of Town and Country Planning has interpreted the amendments at the policy level. Local authorities' involvement is essential in following each stage and requirement in implementing the SIA process. In Malaysia, systematic development in terms of governance and efficient and mutually beneficial service management of all parties. A system of government in Malaysia practices a federalism system that consists of three levels of administration, namely the Federal Government, State Government, and Local Government.

Regional and local governments are essential for local development processes but are not the only regional administration. This stage causes multiple levels between different levels of government to ensure that local government is not missed and not considered by national or international administrations, allowing for the proper development process (Delgado-Baena et al., 2022). Involvement in development processes involving regional and local governments should be given attention in the development process. This involvement has a better impact at the local level and helps provide more inclusive development, especially to the local community, which is directly involved in development planning.

SIA is a process that includes analyzing, monitoring, and managing the intended and unintended social consequences, both positive and negative, planned interventions (policies, programs, plans, projects), and any social change processes invoked by such interventions. Its primary purpose is to create a more sustainable and equitable biophysical and human environment (The International Principles for Social Impact Assessment, Vanclay, (2003). Social impact assessment (SIA) identifies and manages industrial projects' social impact. It can also be applied to policies, plans, and programs. SIA is used to predict and mitigate negative impacts and identify opportunities to increase the local benefits of the community and the wider community (Wilson, 2017). Social life is meaningful by looking at social development and social

growth to progressively improve life and the quality of life that society should enjoy. The impact of development should reflect the benefits to the community, as the development, proposed and approved by local authorities, should be given greater attention to give back to society.

Vanclay (2003) stated that past studies have discussed in terms of principles, concepts, and methodologies for social impact. Therefore, the need for SIA in the development process is critical as this is an approach to reduce the negative impact on society. In addition, studies conducted by previous researchers are also crucial because developing countries are constantly changing the need to meet human needs. Past SIA researchers provide information that helps provide decision structure and appropriate development strategies for better results. The need for this approach and study helps in avoiding cost repetition and time-taking errors as well as reducing the negative impact of development (D. R. Becker, Harris, Nielsen, & McLaughlin, 2004; Esteves & Vanclay, 2009; Gârboan, 2005; Potter, Binns, Elliott, & Smith, 2008; Taylor & Burdge, 2004; Walker, 2010).

## METHODOLOGY

The qualitative method was adopted by using literature review analysis, with references from books, articles, and development reports.

## LEGAL REQUIREMENT

Malaysia has a framework in the law that supports public engagement at various stages in the decommissioning planning. Still, it has yet to be seen in a focused and significant manner in the development plan, development proposals, and policy. Efforts to involve public involvement in the development process are expressed at the Federal, State, and local levels in asserting the importance of public engagement. However, it is often the public who are not aware of the importance of involvement or do not cooperate in taking action on the

development proposals provided. In the Town and Country Planning Act (Act 172) and Local Government Act 1976 (Act 171), there is a state of involvement of Malaysians in the planning process.

The Town and Country Planning Act (172) Part III – Development Plan, Section 9 states, 'When preparing for a draft structural plan in an area and finally determining it is contained for approval, the local authority should take steps as in the opinion:
1.     that publicity is given in its field to the survey report under Section 7 and to the matters proposed to be included in the plan; and
2.     that persons who may be required to obtain the opportunity to make representations to the local planning authority in respect of such matters are informed that they are entitled and given the opportunity to do so, and the local planning authority shall consider each representation made within the period specified to it.

Through the statement, local authorities translate development planning into the form of inclusive needs and well-being. In the National Planning Policy (NPP) (NPP) (2012), it states under Paragraph 55, "Local planning authorities should consider whether unacceptable development is acceptable through the use of planning conditions or obligations. Planning obligations can only be used where it is impossible to deal with unacceptable impacts through planning conditions." explaining that any planning has conditions that need to be seen as the impact of the development is acceptable and applicable to the state of the development.

i.     Association between Local Government and SIA
The legal mandate for SIA in Malaysia has also been expanded through amendments to the Town and Country Planning Act and how the Department of Town and Country Planning has interpreted the amendments at the policy level. Local authorities' involvement plays an essential role in

following each stage and requirement in implementing the SIA process. In Malaysia, systematic development in terms of governance and efficient and mutually beneficial service management of all parties. A system of government in Malaysia practices a federalism system that consists of three levels of administration, namely the Federal Government, State Government, and Local Government.

The preparation of the development plan according to the development planning needs is seen as the planning arrangement. In order to obtain development plan approval, several stages must be passed from the initial stage to the approval stage of the plan. Each stage includes planning the development according to the criteria and requirements set as per the development guidelines at the local authority level.

Functions of a local authority administration in providing for the needs of social facilities as stated in Sections 101 and 102 of the Local Government Act 1976 (Act 171) for Sections 5 (1) and 6 (1) enshrined in the Town and Country Planning Act 1976 (Act 172). Local authorities are also planning agencies that formulate comprehensive and informative strategies and programs to achieve national goals. This goal focuses on a prosperous quality of life and enjoying a socio-economic status in line with the country's progress. The role of local authorities should also focus on development and improvement that requires adaptation to the current situation. This role is so that the local authority can function as an authority that monitors the development and meets the wishes and demands of the local community.
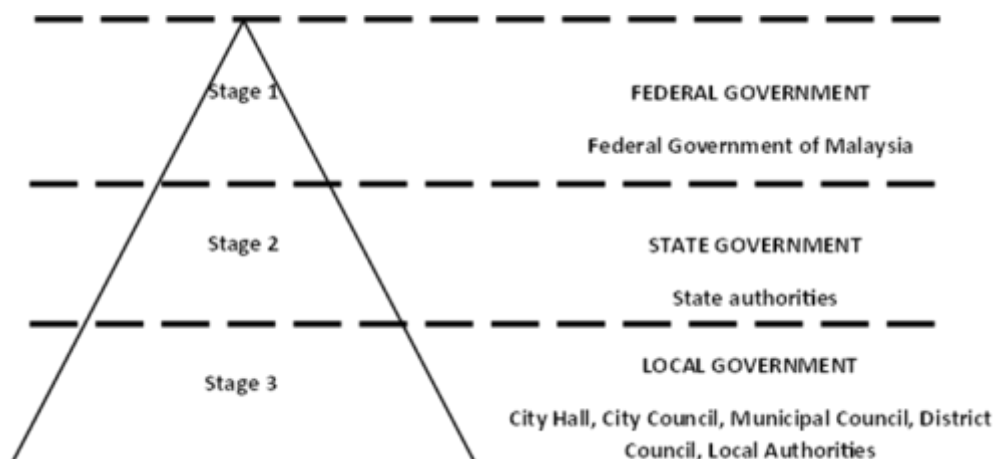


**Figure 1** Government administration at the federal, state, and local government levels
Source: A Systematic Review of the Issues Affecting Local Government in Malaysia, 2019

The involvement of local authorities in allowing development approval is seen as an essential planning process. Planning permission as a planning control tool gazetted in the Town and Country Planning Act 1976 (Act 172) – Section 2 (1) "planning permission" means the permission granted, with or without conditions, to carry out the development." Any development planning proposed and wishing to be developed will go through the planning permission process. In reference to this explanation, Section 21

(1) "An application for planning permission in respect of a development shall be made to the local planning authority and shall be in the form and shall contain particulars and be accompanied by the prescribed documents, plans, and fees."

This statement indicates that the Local Authority is involved in this process and shows that all approvals are also in force under the Local Authority. Local authorities are directly involved in allowing a plan according to the requirements

proposed under the local plan of an area. Development planning should be prepared following the needs and development that have a positive impact, especially on inclusive development and the well-being of the community and society. The involvement of SIA as a reporting process, such as EIA report and Traffic Impact Assessment (TIA) report, which is referred to for project approval at the stage before planning permission is carried out. The requirements of this report depend on whether the project planning is in a category that requires an impactful impact study or not.

Regional and local governments, as in Figure 1, are essential organizations for local development processes, but they are not the only regional administration. This stage causes multiple levels between different levels of government to ensure that local governments are not missed and are not considered by national or international administrations, allowing for proper development processes (Delgado-

Baena et al., 2022). Throughout the development process, the authorities in regional and local government involvement of the development process and the impact on the community should be given attention. This involvement has a better impact at the local level and helps provide more inclusive development, especially to the local community, which is directly involved in development planning.

The rule-making procedure can be defined as the sequence of actions determining the material of the rule of law. This definition leads to the main legality since the material of the rule of law is at the forefront: the rules must follow the law. Based on the statement, taking the focus of the rules as a starting point, the rule-making procedure must be conceptualized as a combined tool for performing the procedure or, in other words, as forming the final decision based on the law.

ii. The Implementation of SIA
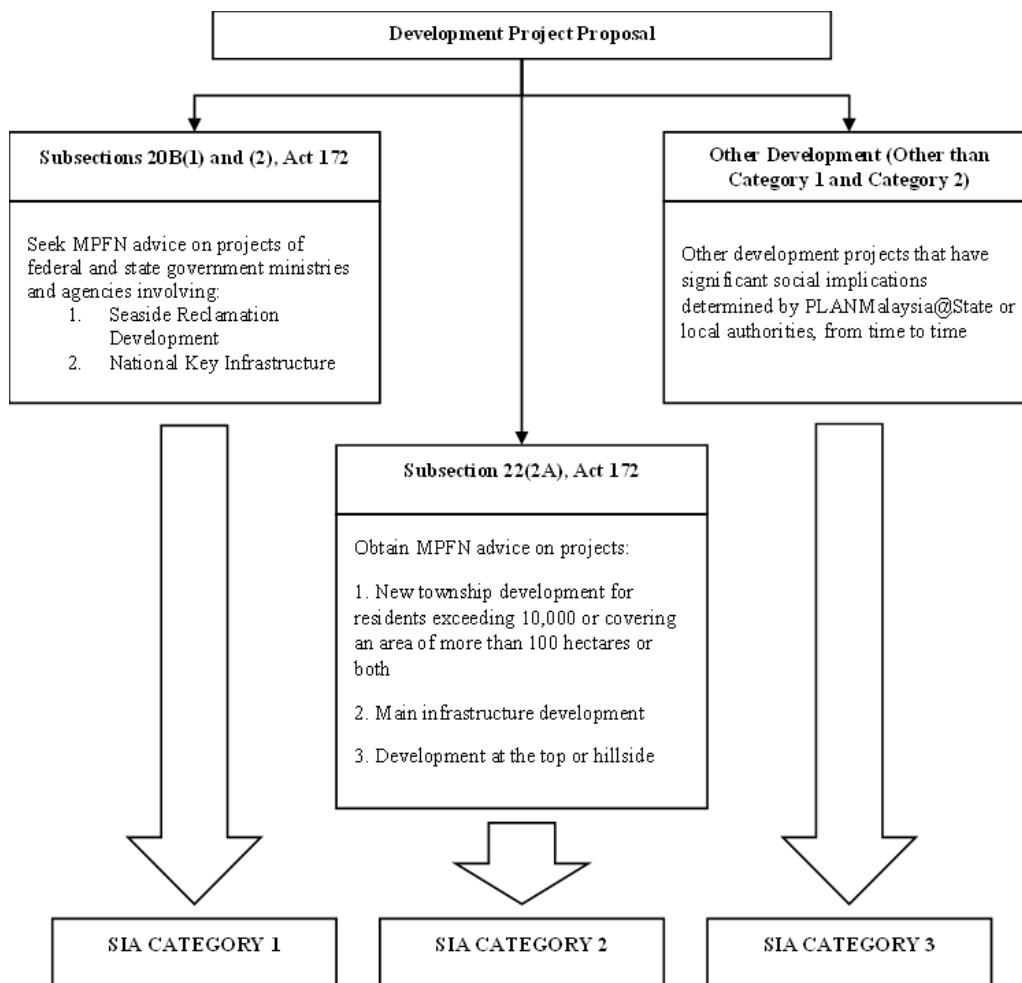
**Figure 2** Scenario for preparation of the SIA report

Source: A Review of SIA Procedure in Malaysia, 2018

*Have not applied for planning permission from the Local Authority and do not yet have a detailed layout plan
**Have applied for planning permission from the Local Authority and already have a detailed layout plan

Figure 2 shows that in Project development, SIA category 1 covers the development planning process under the Town and Country Planning Act 1976 (Act 172), section 20B, which states the advisory requirements of the National Physical Planning Council (MPFN) at the initial level. This process involves the development proposal, and the SIA report should be submitted to the MPFN. SIA Category 2 includes development projects under subsection 22(2A), Town and Country Planning Act 1976 (Act 172), which should be referred to MPFN for advice. The development project under subsection 22(2A) is a large-scale and high-impact development. The SIA report's requirements should be prepared per the subsection. SIA Category 3 covers development projects determined by the PLANMalaysia@State or Local Authorities through state consultation, which may be updated occasionally.

Generally, Category 3 SIA includes projects not involved under Category 1 and Category 2 SIA and are listed by PLANMalaysia@State or local authorities with significant social impact. The provisions of SIA Category 3 also cannot be considered with only the preparation of the Development Proposal Report prepared under paragraph 21A(1)(ea), Act 1522. Therefore, the SIA report should be prepared and evaluated separately for development projects with such characteristics.

Public involvement as one of the processes before planning is proposed as is significant as the principles and means used in the case of 'Director of Lands and Mines, Wilayah Persekutuan v Sri Lempah Enterprise Sdn Bhd,' under the Federal Court, Kuala Lumpur, 12 September 1978, 21 October 1978 by Raja Azlan Shah AG CJ (Malaya). Several points that he has argued through the principles along with the conditions for development and planning permission, such as; (i) The Local Authority has a discretionary limit in issuing any conditions; (ii) the conditions stated must be valid, fair, and reasonable to the application for the planning applied for; (iii) Local authorities must act following the duties and conditions of development should be reasonable: and (iv) the Local Authority shall not use its powers for matters that are not reasonable to the duties and objectives and in accordance with the public interest. Through the formulation of this case, the Local Authority does not have great power in determining the importance of a development plan that has a good impact on the community.

Through this statement, SIA's involvement in the development planning process can assist in identifying social issues that arise in the local area. Development theories have changed from economic growth to poverty reduction and human welfare. Furthermore, This is because the political and social aspects are not considered along with the economic aspects (Abas, 2019). Acceptance and adoption of the SIA process in planning can focus on the needs and opinions of the community and society that development will impact.

iii.    Planning Permission
Local authorities serve as the governing body and planning of land development, facilities, and space preparation to place a plan in an area designated by the government and the federal government (Rafidah Asyikin, 2011). Town and Country Planning Act 1976 (Act 172) states a number of special provisions in addressing the issue of responsibility for State Authorities and Local Authorities. In a development, approval for the planning

is under the jurisdiction of the Local Authority and will face limitations when there is a directive from the state Planning Committee. The need for the involvement of the State Planning Committee and the Local Authority is a procedure that looks at the expertise in the jurisdiction of planning the administrative area.

However, the preparation of the SIA report in the planning permission process under the local authority is still seen as not getting a response or encouragement from the local authorities. The implementation of SIA in the Town and Country Planning Act 1976 (Act 172), as a guide, has not been established to guide local authorities to use the SIA assessment in the planning permission process is still less impactful. The impact assessment provides the method for applications made by urban planners in the planning process that assists in the plan's impact on the studies carried out. An essential requirement in this evaluation process is the involvement and cooperation of agencies and institutions for studies.

**Table 2** Provisions that include the Social and Legal in the Town and Country Planning Act 1976 (Act 172)

| Social Inclusivity Provisions | Legal provisions |
|---|---|
| Preparation of the Structure Plan | Subsection 9 (1a) Public engagement<br>Subsection 9 (3) Public Objection to the Draft Structure Plan |
| Local Plan Preparation | Subsection 12A Public involvement in the preparation of Local Plans<br>Subsection 13 Public Objection for Draft Local Plan |
| Planning Permission Stage | Subsection 21 (6) Objections from neighboring landowners<br>Subsection 21 (7) Objections received<br>Subsection 21 (6) There is a legal presumption that there is no need for site notification and request objections from adjacent landowners if there is a Local Plan.<br>Subsection 21A (1A) of the State Authority may give instructions to include the Social Impact Assessment in the Development Proposal Report (LCP). |
| Rules | Subsection 58 (1) The State Authority may make rules to carry out the purposes of this Act. |

Source: A Review of SIA Procedure in Malaysia, 2018

Table 2 shows that, at the planning permission stage, the Town and Country Planning Act 1976 (Act 172) states under Subsection 21A (1A) that it is for the preparation of development proposal reports need to be prepared at this stage. The State Authority can provide instructions to ensure that the Social Impact Assessment should be submitted in the Development Proposal Report (LCP) at the planning stage. In accordance with the provisions of the law, in particular Subsection 19(1), Town and Country Planning Act 1976 (Act 172), for each development proposal, it is necessary to obtain Planning Permission (PP) from the Local Authority before the development can begin, be carried out or operated. The approach to setting the PP category based on the intensity and risk of development is critical. The determination in terms of the method of service of processing approval also includes the determination of the number of days of processing and the requirement of the checklist of documents at the stage of submitting the proposal.

Through the case of Kajing Tubek and ORS v Ekran Bhd. Dan ORS is a case under High Court, Kuala Lumpur, 19 June

1996, James Foong J, who argued the importance of impact assessment at the public level in expressing any doubts, views, and opinions on a development plan. The residents of the longhouse in Belaga, Sarawak, are affected by the development of a hydro electrification project proposed by the government in Bakun, Sarawak. The 'Environmental Quality Order (Environmental Impact Assessment) Amendment 1996' ordered provided that the prescribed activities do not apply in Sawarak. The public claims that their homes and land are affected and will perish by the project, and they are also the ones who will suffer directly compared to other members of the public.

This case shows that the impact assessment is not a matter or process that is not of interest to the public. However, in the early stages of the proposal, the planning of this project will be beneficial and advantageous to the public. The public, who are aggrieved parties, directly have their views and opinions on the proposed development planning.

The public and aggrieved parties are local residents who understand the surrounding area for the proposed development. Through impact assessment, most of their views and voices can be raised and highlighted in the assessment report, especially the SIA report in the development planning process as a decision-making tool at the local authority and top level.

## DISCUSSION

The SIA study is fascinating in development planning impact studies, involving making decisions to understand the consequences of predicted development planning decisions (Hassan, 2018). The decisions taken need to look at the impact of action and impact the affected communities and socials can not only know the consequences of development to the local community but are directly involved and participate in planning the future of development planning. In Asia, where there has been a lot of development through similar EIA procedures globally and through the experience process, institutionalizing SIA is limited. Countries such as Taiwan, Malaysia, Indonesia, and Hong Kong began developing EIA systems in the late 1970s. According to the date, this country's progress has changed (Leu, Williams, and Bark, 1997; Wood and Coppell, 1999). This exposure has led to the recognition of the social dimension of the environment and the need for assessment of social impact in the system of development structures is given attention.

SIA includes changes in the way of life of citizens, culture, community, political system, environment, health and well-being, personal and property rights, and fears and aspirations. The change in SIA requirements is seen in terms of agreement between practitioners and institutions on some of the key aspects and characteristics of the SIA. There are ten principles stated in Social Impact Assessment: Integrating Social Issues in Development Projects (2018) by promoting SIA (1) Equal opportunities, inclusion, and sustainability in the project environment; (2) Local benefits, community development, and capacity; and (3) Empowerment and social capital. The SIA principles provided by Social Impact Assessment: Integrating Social Issues in Development Projects (2018) should also be (4) Be part of proactive and essential project planning and implementation interrelated with economic, physical, environmental, and other issues; (5) Address both risks and opportunities; (6) Be strict in the use of data, which may include quantitative as well as qualitative data; and (7) Widely used in different contexts and settings.

The outcome of the SIA approach should also focus on (8) Building local knowledge and participation processes and reflecting diversity in culture and values and (9) Respecting and promoting human rights, transparency and accountability, and the rule of law. However, the provision of SIA

also cannot (10) Apply coercion or improper force. Preparing the SIA report, which is seen as an approach and tool that focuses on social development and social involvement in development planning, can help avoid any developmental impact, especially on the local society. This principle is also a general guide in helping practitioners of SIA studies prepare a systematic and inclusive report on social development.
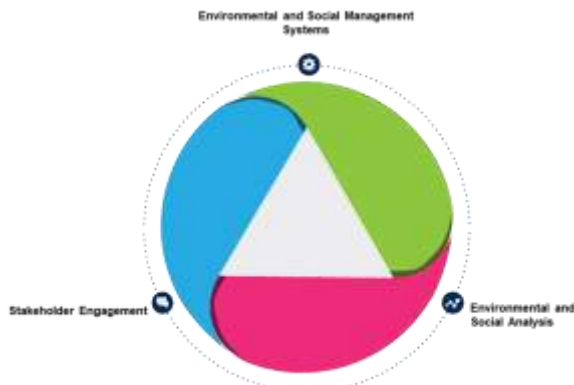


**Figure 3** Three-dimensional Guide to the Integration of Social Issues

Source: Social Impact Assessment: Integrating Social Issues in Development Projects, 2018

Based on Social Impact Assessment: Integrating Social Issues in Development Projects (2018), Figure 3 shows that integrating social issues in the development of the project involves a total of three aspects, namely (1) in terms of Dimensions Analysis, which involves a comprehensive assessment and documentation in a social context and the possibility of project impact, both positive and negative to social; (2) Dimensions of Participation, which involves engaging with project stakeholders in a meaningful manner and giving public opinion and views; and (3) Management Dimensions, which focus on analytical and participatory elements are included in the project and management decision-making system, during preparation and implementation. Through the dimensional aspects provided by the Inter-American Development Bank (IDB), SIA's needs in development planning can have a social impact in both positive and negative impacts.

The term "social license to operate" is a metaphor for the degree of support given to the project by the local community and other stakeholders, and it emphasizes the relevance of social concerns (Parsons and Moffat 2014; Jijelava and Vanclay 2017, 2018). The statement of social license shows that the need to understand the impact of development on social issues will help the level of acceptance of the development proposal to the community or the public and other stakeholders. Social issues closely related to the local community will use the development carried out for local social development.

In the OSC 3.0 Manual, there is also need to prepare a Social Impact Assessment (SIA) regarding the SIA Manual. A separate SIA Report for development under Subsection 22 (2A) of the Town and Country Planning Act 1976 (Act 172) may also be prepared SIA approval letter for development under Subsections 20B (1) and 20B (2) of Town and Country Planning Act 1976 (Act 172), which interprets development planning from the national level, focused on PP as a step towards achieving sustainable development goals. This process involves a thorough and balanced consideration through the local authorities following the country's development policies, which are also a factor in the way before the PP is handed over.

Sustainable development aspects that consider the environmental, physical, economic, and social elements are essential by making PP the primary basis in development planning. The OSC 3.0 manual also states that the need for the preparation of SIA reports is a development planning process by providing documents through medium PP and large PP. The need for this preparation is also reflected in the requirements of the SIA Manual with the development category requirements for the planning.

## CONCLUSION

Social Impact Assessment (SIA) is a tool and method used in making forecasts and decision-makers that are studied through social assessment methods involved in the impact of development. The results must also be taken from the impact assessment studies before action is taken, and the stakeholders involved can give their opinions and views on the development to be approved.

The main essence of Act A1522 has required the departments or agencies of the Federal Government and the State Government to seek the advice of the National Physical Planning Council for the proposed development proposals to emphasize the social aspect. This Town and Country Planning Act 1976 (Act 172) (A1522) ensures that development-related outcomes and decisions have considered the social impact on communities and individuals.

Any future development projects around the capital must prepare TIA and SIA before being approved by the Mayor based on the Kuala Lumpur development plan (Khalid Abdul Samad, Bernama, 2019). Social impact assessment studies must be carried out before any approval is given to property developers (Prof Dr. Ismail Omar, Berita Harian, 2022).

Public policy or policy is becoming very important nowadays in the context of scientific and practical perspectives. A deep understanding of the causes and effects of public policy on society is essential for strategic improvement in the scientific context of Perspective (Abas, 2019). In applying kindness in development practices, it is best suggested that SIA and projects should contribute to the development and empowerment of the community (Esteves et al. 2012; Vanclay et al. 2015).there are three main points by which it is achieved: (i) the participation of the affected person in decision making; (ii) effectiveness in the reduction of negative effects; and (iii) increased benefits (João et al. 2011; Vanclay and Hanna 2019).

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# THE CHALLENGES OF URBAN ENVIRONMENT AND MENTAL HEALTH: AN OVERVIEW

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## ABSTRACT

Urban health is a worldwide concern, and urbanization seems to be on the rise and poses significant challenges to mental health. These issues are made even worse by unplanned rapid urbanization, such that it is occurring in many emerging nations. This review's objectives intend to update readers on urban mental health challenges and to draw attention to critical matters that need swift actions. According to recent data, most of the population lives in cities, and urbanization is predicted to rise everywhere. Many health issues in urban areas are undoubtedly related to social determinants such as unemployment, poverty, overcrowding, lack of green space, high crime rates, and a lack of mental health resources. These are challenges for mental health in urban environments. To assist policymakers and urban planners in improving mental health care facilities, more research studies and detailed guidelines should be promoted. Additionally, there should be more methods to prevent and mitigate mental health difficulties in urban environments. This work was reviewed using (n=65) research articles from previous years that addressed the topic of urban mental health. There is mounting evidence that the urban environment and mental health are associated.

*Keywords: urban environment, mental health, urban mental health, urbanization*

## INTRODUCTION

The rapid increase in the number of people living in urban areas raises several health-related issues (Krabbendam et al., 2020). These include both physical and mental health. Urban spaces also present specific challenges in people's settings and activities. Social, economic, and environmental issues associated with urbanisation have an impact on mental health (Freeman et al., 2014). It has been demonstrated that common mental health problems are more prevalent in cities.

Urban mental health is known to be impacted by social inequalities, instability, pollution, and a lack of access to nature (Ventriglio et al., 2020). Benefits of city living may include easy access to healthcare and cultural offerings. Nevertheless, epidemiological research consistently shows that mental health issues tend to worsen in cities (e.g., Vassos et al., 2016; Pedersen et al., 2013). Given their brief evolutionary history, humans may not be able to withstand the negative effects of urban

environments (Vugt & Colarelli, 2017 for an overview).

## LITERATURE REVIEW

### *Urbanization*

Greater numbers of people are becoming involved in the global phenomena known as urbanisation. Globally, there are currently 3.9 billion urban dwellers, up from 746 million in 1950; by 2050, it is expected that there will be 6.4 billion urban dwellers. (U.N., 2019). Different levels of population exposure to mental health risk factors exist in newer urban areas: including the macrosocial, relational/supportive, and macroenvironmental levels (Carta MG, 2019). Changes in socioeconomic factor that influence health, such as housing and living circumstances, availability to nutritious food, and the health care system, may result from urbanisation and migration from rural to urban areas (Bhugra et al., 2019).

A well-planned infrastructure and government programme that does not coincide with urbanisation could have negative implications (Okkels et al., 2017). Examples of the consequences include informal settlements, traffic, pollution, homelessness, crime, loneliness, and single-parent families (Gurney KR, 2015 and Cruetzig F et al., 2015). Due to the rapid demographic change, an increasing number of people who live alone face loneliness, anxiety, and depression (Okkels et al., 2017). Essential services including transportation, water, sanitation, and healthcare, especially mental health services, are put under pressure by the growing urban population.

More people than ever before live alone, experience loneliness, anxiety, and depression, and this rapid demographic transformation has a huge impact on how people live and interact (Srinivasa V et al., 2016 & Seto KC et al., 2016). The growing urban population also puts a burden on critical services including traffic, water, sanitation, and healthcare, particularly mental health services. There is inadequate information on how globalisation affects mental health. Nevertheless, it has been asserted that urbanisation mediates the relationship between environmental, social, and economic factors and mental health issues (Bhugra et al., 2019). According to Marmot M. (2016), social and economic contexts may have an impact on physical and mental health. He made the argument that an individual's growth is influenced by social stratification as well as economic and political power.

It is critical to identify the components of a natural or urban environment that may have an impact on a person's psychology in order to examine how the urban environment is related to mental health. Social traits such as high population density, poor social cohesion, frequent violations of personal space, and severe socioeconomic deprivation may be considered plausible urban impacts (Galea et al., 2015); (Heinz et al., 2013). According to Attademo et al. (2017) and Rautio et al. (2018), environmental pollution, a lack of green space, and other city features that are generally referred to as "urban stress" can all lead to increased risk. Studies documenting geographical variation and investigating the extent to which social and material components are significant for urban designs that reduce risk and improve safety (March et al., 2018 and Adli et al. (2017).

With a focus on the global context and issues we believe need immediate attention, we aim to update existing studies and research on urban mental health in this article.

### Urban Environment and Mental Health

As maintained by the World Health Organisation (2020), mental health is one of the three basic components of health, along with physical and social well-being. People with good mental health can be defined as individuals who can: (1) realise their own abilities; (2) cope with the normal stresses of life; (3) work productively; and (4) contribute to their community (World Health Organisation, 2018).

However, many people fail to meet this standard. In England, for example, National Health Service (2021) disclosed that one in four adults experience mental illness. Data from China (Huang and Zhao, 2020; Liu et al., 2020; Zhang and Ma, 2020), Europe (Banna et al., 2020; Gualano et al., 2020), Australia (Fisher et al., 2020), and the United States (Fitzpatrick et al., 2020) have reported that mental illness often appears in the form of depression, anxiety, and stress. Such mental health disorders, as reported by Bloom et al. (2011), incurred around $2.5 trillion loss globally in 2010, and this figure will rise to $6.0 trillion by 2030. According to Rosenberg et al. (2020), this situation has been exacerbated by the unprecedented COVID-19 pandemic where people experienced persistent mental health problems due to the considerably long lockdown, and the health system's failure to contain it. These staggering statistics highlight that mental health has become an issue that cannot be ignored.

Studies have been conducted to investigate the causes of mental health (e.g., environment, social relationships, and employment) and subsequent countermeasures (Weich et al., 2002; Nurse et al., 2003; Hudson, 2010; Sullivan and Chang, 2011; Appelqvist-Schmidlechner et al., 2020). Among them, increasing attention has been paid to explore its relationship with the built environment, given that people spend 90 percent of their time in buildings and frequently interact with their surrounding environment in their daily lives (Klepeis et al., 2001; Evans, 2003; Wright and Kloos, 2007; Reichert et al., 2020). For example, Sullivan and Chang (2011) found that the lack of green space, and crowded and noisy places are usually associated with psychological distress and even depression. In terms of housing tenure, Berglund et al. (2017) reported that poor mental health was found to be lowest in people living in private houses. It has also been shown that good indoor environmental quality (e.g., thermal comfort, lighting, and natural view) can be conducive to decreased stress, reduced anxiety, and improved mood (Santamouris et al., 2014; Akbari et al., 2021). Hence, urban environment design should aim to sustain mental health of the residents in addition to its physical and cognitive functions.

During COVID-19 pandemic lockdowns, people spent much more time (i.e., 24/7) at home than before, rendering mental health an ever-increasing concern (Dawson and Golijani-Moghaddam, 2020; Singh et al., 2020). This is well illustrated in the doubled prevalence of moderate-to-severe depressive and generalized anxiety symptoms following the restrictions put in place to halt the spread of COVID-19 (Fisher et al., 2021). Markedly, the pandemic has imposed greater challenges on the pre-COVID situation where disability was mainly caused by mental health disorders and that the overall mental health condition is still deteriorating (Office for National Statistics - ONS, 2017). Although existing studies have identified urban environment design as a contributing factor to mental health, its specific influence during the COVID-19 lockdowns, when people spent almost 24 hours at home, remains unclear. In addition, previous studies often focused on a single set of characteristics of the urban environment, such as the construction of new roads around the neighbourhood (Egan et al., 2003), neighbourhood social and physical characteristics (Cerda et al., 2013), and indoor environment quality (Burns et al., 2019), without considering the agglomeration effect (i.e., how the addition

of multiple built environment factors impacts their effect).

To fill this knowledge gap, this paper aims to examine the challenges on how built environment impacts the mental health. There are several factors associated with urban living that can affect mental health such as poverty, unemployment, overcrowding, noise pollution, poor infrastructure, and lack of green space. As the world's population transitions to becoming primarily urban, examining the benefits and drawbacks of urban development on mental health is as important as ever (Singh, 2019).

Large-scale demographic data demonstrate that urban living, in addition to genetic susceptibility, increases the incidence of mental problems (Abbott A., 2013). All major conditions may be included in the socio-environmental concept of mental illness, which was initially developed for schizophrenia (Gruebner et al., 2017). An increased prevalence of mental problems has been linked to residing in or growing up in an urban setting (Peen et al., 2020). Social support on both a personal and communal level may be a preventive against mental illness (Bhugra et al., 2019). It may be difficult to maintain fruitful social relationships in urban environments and megacities due to the fast-paced nature of city life, daily commitments, lengthy distances, and the increased average amount of travel time (Sariaslan et al., 2016). Urbanization is linked to more convenient access to social media, the internet, and free Wi-Fi, which discourages face-to-face contact with neighbours. For instance, mental health patients who reside in rural areas report more frequent social contact than those who do in urban areas (Schomerus et al., 2017).

Due to the perception of insecurity and violence, there may be fewer direct social interactions in cities. Numerous studies have demonstrated that both the general public and those with mental health issues perceive more insecurity and personal risk of violence when living in urban areas (Luciano et al., 2016 & Schomerus et al., 2017). Insecurity, violence, trauma, and an unorganised neighbourhood may all lessen social support and contact and have an adverse effect on wellbeing and mental health, according to Stockdale et al. (2017). As a result, communities with higher levels of social support and group effectiveness may lessen perceived stress through promoting mental health support networks (Jacobi F et al., 2014 & Frick et al., 2013).

Additionally, it was suggested in a study by Fone et al. (2014) and a study by Maimon et al. (2020) that social support networks in neighbourhoods may potentially contribute to urban social norms and practises that are protective against substance use disorders or suicide attempts. Urban housing is another indicator that has developed as a major issue alongside expanding urbanisation, in addition to the local environment (Okkels et al., 2018). Reform, rising real estate prices in urban areas, increased inequality, and the breakdown of social networks in both urban and rural areas are some of the main causes.

Given the challenges of urbanisation in various places, it is important to comprehend the structure of density and the factors that affect it. Due to its significance for purposes of safety, comfort, and asset, the house stands out as the most important of all features. According to Dempsey et al. (2013), housing density has an impact on social sustainability and improves mental health (Husin et al., 2021). Additionally, the selection of suitable house types and housing density are correlated. Residential density can be defined in many ways to meet different needs in urban planning, according to Keeble (1969), who claims that there has never been or is currently a system of measurement and regulation of residential density that can fulfil all needs or purposes and still has not been developed (Awad, 2012).

The physical environment and characteristics made by people and intended use compensate the built environment. Housing is a significant component of the built environment because it gives people a place to live and work and provides them with the shelter they need. Due to the greater cost of living and lack of available land and space in urban areas, most residents struggle to buy a home that would allow them to live comfortably and better. As a result, the low-income population will live in affordable shanty towns or low-cost homes in urban areas (Ghazali NM et al., 2021). Living in a home with decent housing conditions, enough room, higher housing quality, and solid housing affordability will improve individual's mental health (Wang et al., 2018; Hoisington et al., 2019; Qiu et al., 2019). Housing disadvantages include cramped living quarters, mortgage debt, delinquency, housing mobility, and tenure can affect mental health, according to Singh et al. (2019). Evans (2003) listed the direct effects of housing characteristics on mental health, including house type, floor level, housing quality, and neighbourhood quality.

Mental health is correlated with housing types, floor levels, densities, overcrowding, and quality (Shenassa et al., 2007; Qiu et al., 2019; Barros et al., 2019; Beemer et al., 2019; Ferguson & Evans, 2019; Marzukhi et al., 2020). Constant findings according to Li and Liu's (2018) conceptual framework, housing can worsen mental health problems and perceived stress due to pressures in the home and neighbourhood, housing costs, overcrowding, limited indoor amenities, unstable housing, and physical and social deprivation. In accordance with Astell-Burt and Feng (2018), community satisfaction, such as neighbourhood relationships, can indirectly affect mental health. Housing factors, like floor plans and amenities, can have an immediate impact on mental health (Evan, 2003).

The extent of sustainability varies in different. One aspect of urban design that has been extensively researched and found to have an impact on neighbourhood sustainability is density. It is a standard language that designates things for each place, such as buildings, rooms, individuals, or units. One of the huge consequences of urbanisation, it leads in issues such an increased demand for housing. At both the macro (urban) and local (neighbourhood) levels, density is the aspect of urban look that is easiest to assess (Rani & Shamsuddin, 2013). Based on study by Ghazali et al., (2021) on urban low-cost housing shows recurrent findings about the importance of mental health.

Urban planning or urban design is another crucial attribute for the urban environment and mental health concerns (McCay et al., 2017). It is well established that uncontrolled, rapid urban growth contributes to poorer mental health, as well as homelessness, filthy conditions in informal settlements, crime, and drug misuse. Urban planning is the process of designing and constructing homes and streets before people move in. It involves local decision-makers, entrepreneurs, architects, and engineers. It covers the construction of homes, roads, buildings, parks, and walkways as well as public transportation, access to green spaces, and opportunities for social interaction and physical activity (Okkels et al., 2018). Many present cities have their large chain stores centred on sizable malls, and their residents work in offices in the business district while living in sizable suburban villa neighborhoods. In this configuration, life activities are physically scattered, requiring daily long-distance travel. They travel to work, school, or the grocery store by automobile or public transportation (Liu et al., 2018).

Urban planners have recently started to create cities with features that are likely to boost physical health (e.g., to help prevent obesity and cardiac disease) (Peen et al., 2020). Urban planners need to understand how urban settings impact mental health as well. The four pillars of active spaces, pro-social spaces, safe

spaces, and green spaces might be the emphasis of urban designers. Of course, functional places might also include outdoor gyms, better access to public transportation, and infrastructure that promotes cycling or walking. Spaces that are safe and conducive to social interaction should be well-lit, situated wisely, and shielded from road noise and pollution. Further enhancing the safety of public areas is the installation of windows in the walls of homes that face streets, as well as the avoidance of sight-impairing barriers (McCay et al., 2017).

Urban planning should encourage social interaction, physical activity, and nature-based experiences; green spaces (Sia et al., 2016). Social stress and economic stress should be addressed through local urban planning and social security. Together, policymakers and urban planners must take measures to limit air, light, and noise pollution, encourage walking and bicycling, accessible public transit, accessible health care services, and foster social cohesion in liveable, well-planned neighborhoods (Bhugra et al., 2019). All these approaches for promoting urban mental health, reducing risk factors for mental distress, and according to a 2019 recommendation by Baumann et al., initiatives that improve the inclusion of people with mental illnesses in urban settings should be categorised under the term "urban remediation."

Integrating green spaces in urban environments is another challenge for urban mental health (Kua & Sia, 2016). There aren't enough spaces in the urban, which reduces social interaction and raises the standard of living (Okkels et al., 2018). (Baumann et al., 2019). This is crucial since residing in a megacity with a high density of people and little to no access to green spaces is linked to poor mental health. Green urban spaces reduce traffic noise and improve air quality. Additionally, green places reduce stress and promote social contact among urban people (Li et al., 2018). Living close to green urban areas and experiencing

less mental distress are strongly correlated, according to a poll of more than 10,000 people from the United Kingdom. Green space is now being deliberately incorporated into city development in some places, like Singapore.

According to the research discussed above, living in an urban environment may influence someone's mental health. The following are just a few of a lot of challenges today are dealing with social stress, substance abuse, loneliness and social isolation, noise and pollution, crime, and insecurity; crowding and diminished privacy; economic stress; low physical activity; poor transportation conditions; and lack of access to nature. Todd Litman published a list of the causes and reasons for poor mental health in cities in 2017. According to the research discussed above, living in an urban environment may influence someone's mental health. A recent Canadian study found that living near busy roadways increased the risk of dementia (Chen et al., 2017). Multiple studies involving more than 60 million Americans found that air pollution can harm health even at levels that are currently regarded as safe for Americans to breathe and it is associated with individual mental health (Di Q et al., 2017). These articles highlight the serious health risk that urban pollution poses and should be used to advocate improved urban planning and access to green places. However, because there aren't many high-quality studies in this field, it's challenging to properly explain the causal relationship between green spaces and mental health (Gascon et al., 2015). However, because there aren't many high-quality studies in this field, it's challenging to properly explain the causal relationship between green spaces and mental health (Gascon et al., 2015).

Multiple studies strongly suggest that green spaces may be stress-relieving, and people who live in greener urban areas report experiencing less mental distress effective mental well-being (White et al., 2013). By reducing levels of air pollution caused by traffic, exposure to

more residential green space has been linked to better early childhood neurodevelopment in 2019. (Liao et al., 2019 & Kumar P. et al., 2019). In a systematic review of research analysing the impact of urban green-blue spaces on human health, Labib et al. (2019) confirmed the link between exposure and improved mental health outcomes among the exposed population. There are some theories that have been put forth to explain the connection between green spaces and mental health. These theories include the biophilia theory (Wilson EO. 1984), which is based on a subconscious biological desire to interact with other species, the stress reduction theory (Ulrich RS. 1983), which claims that green spaces have a "dose-response" effect on stress levels by removing us from the pressures of daily life, and the attention restoration theory (Kaplan R.

The examination of causal links between the length of exposure to urban environment elements and mental health would benefit from additional longitudinal studies in the future.

### Strategies

The research presented above suggests that an urban lifestyle may have an impact on mental health. In 2017, Todd Litman put up a list of causes and reasons for poor mental health in cities, including: Some of the challenges today people deal with include social stress, substance abuse, loneliness and social isolation, noise and pollution, crime, and insecurity, crowding and diminished privacy, economic stress, low physical activity, inadequate transit conditions, and lack of access to nature. Litman suggested potential mitigation measures to lessen

## METHODS

The following set of keywords have been used in a literature search. A complete overview of the expanding urban environment and mental health in relation to global concerns has been provided by

the effect on the general population's mental health considering these risk factors.

First and foremost, it is important to encourage targeted social services to lessen social stress brought on by things like poverty, housing issues (homelessness), isolation of minorities, and immigrants. A second successful tactic might be to make housing and transportation more affordable. Urban designers should consider pro-social spaces like parks and public buildings to promote neighbourhood participation and inclusion of disadvantaged groups, as was previously indicated. Urban planning should encourage social interaction, physical activity, and nature-based experiences (green spaces).

Social security and local urban policy should deal with social and economic stress (Bhugra et al., 2019). To create livable, well-planned communities, policymakers and to reduce air, light, and noise pollution, encourage walking and bicycling, accessible public transportation, accessible health care services, and foster social cohesion, urban planners must collaborate. (Bhugra et al., 2019 & Marmot et al., 2016). To incorporate all these measures for improving urban mental health, reducing risk factors for mental distress, and enhancing the inclusion of people with mental health disorders, Baumann et al. proposed the term "urban remediation" in 2019. Finally, it is essential to support research in this area that outlines widely known standards for policymakers and urban planners to improve mental health and mental health care services in urban environments (Okkels et al., 2018).

this narrative review, which has selected (n=64) and taken into consideration relevant papers over the years of publications.

## CONCLUSION

This research is necessary for assessing the issues associated with mental health

and the urban environment. To supply and enhance the mental health care system, it is essential to comprehend the situation of urban health today. However, due to the fact that urbanisation has varied characteristics and effects depending on history and location, these experiences cannot easily be applied to improve mental health in urban areas elsewhere. Rapid and unplanned urbanisation endangers people's physical and emotional wellbeing. It is time to establish a global political and professional consensus regarding the strategies to direct the growth of urban mental health services. As

a result, this study is pertinent and applicable to future studies on urban mental health.

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# THE CURRENT STATUS OF INTEGRATION DEVELOPMENT ON TAOIST CULTURE AND TOURISM

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## ABSTRACT

This paper examines the proposal that Taoist culture are like other culture could be integrated well with tourism business because there are elements could be digged meeting the needs of people with or without certain culture-background. On-site observation method has been adopted, 4 major cities of 9 Taoist tourism temples of Sichuan, (sites of worship of the Taoist god, the ancient philosopher, Lao Zi) have been investigated. 4 key factors (Age Range and Taoist Belief, Location, Taoist Culture, Tourism Popularity) influence the integration of Taoism culture and tourism development have been analyzed. The author used literature review analysis, four factors from Taoist culture that could be integrated in 3 aspects have been addressed, and 3 ways of integration at certain age range have been proposed. Taoist culture as a daily experienced culture, the study on integration of Taoism culture and tourism could be a plus to both tourism business and tourism development.

*Keywords : Taoist Culture, Tourism Development, Culture Tourism, Tourism Business*

## INTRODUCTION

This paper aims at explore a fusion for the culture and tourism development of a road, through the analysis of the culture of philosophy and religious culture combined with education and tourism knowledge, for the contemporary and the cultural related scenic area of existing project innovation upgrade, and reanalyze the logical relationship between culture and tourism development, for the culture and tourism integration for a contemporary tourism project.

1. Research background and significance

Cultural tourism refers to the behavior process of realizing the purpose of perceiving, understanding and observing the specific content of human culture through touring(Lee et al., 2022). Since the 18th National Congress of the Communist Party of China, General Secretary Xi Jinping has talked about the traditional Chinese culture on many occasions, expressing his recognition and respect for the traditional culture and the traditional ideological value system. On May 4,2015, he had a discussion with students of Peking University and mentioned core

values and cultural confidence many times. In his activities and speeches at different occasions at home and abroad, Xi Jinping demonstrated the spirit of the Chinese government and people and boosted the cultural confidence of the Chinese nation.

Nowadays, the tourism industry is growing rapidly in the process of the continuous development of the cultural industry, and the mutual integration of culture and tourism has become the main trend in the development process of global tourism. Culture is to tourism as the root of tourism, and tourism is to culture as like the leaf of culture. When tourism loses culture as a support, tourism will not have any depth and connotation, while culture will lose the modification of tourism, so it lacks people to inherit and develop. Only when people understand the traditional Chinese culture can they hold the Chinese people's confidence in their own culture, otherwise everything will be out of the question.

Taoist culture, which plays a pivotal role in Chinese traditional culture, has made great contributions to natural philosophy, literature and art, medical health preservation, and religious belief. Taking medicine as an example, the theory of Yin, Yang and the five elements of Taoist culture has also been widely used in traditional Chinese medicine.

And this topic aims at absorbing the excellent composition of the culture, and tourism, do promote the culture at the same time, to protect the Taoist culture, heritage culture, and establish our national cultural confidence, improve national soft power. At the same time, to explore a way of culture and tourism integration development road.

## 1.1 Carry forward China's excellent traditional culture

As the only remaining country among the four ancient civilizations, China has successfully preserved its traditional culture because of the particularity of its characters, and in the study of the ancient sages, the Chinese traditional culture has retained its essence. Its goodness to human beings, the meaning of human life,

and the exploration of human morality have created a glorious history of Chinese civilization for thousands of years. The most influential one is undoubtedly Confucianism and Taoism. Confucianism inherits the thought of Zhouyi; the thought of heaven, and the thought of virtue. In today's social environment, people need a soft and calm thought to ease the pressure of the society. In this point, Taoist culture and tourism have a higher degree of fit than Confucian culture.

## 1.2 Psychological problems of contemporary citizens are increasing

First, the individual physical and mental imbalance. Nowadays, the pace of life is running at a high speed, and the competition for survival is becoming increasingly fierce. Social opportunities and risks coexist, and the people's happiness index is not increasing but decreasing. In this environment, if an individual does not have a set of natural health, effective regulation mechanism, and affected by the excessive influence of the surrounding environment, there will be different degrees of psychological discomfort and obstacles. Moreover, it develops into depression, loss of morale, resulting in physiological disorders, and the gain outweighs the loss.

Second, interpersonal relationship disorders. The test of social environment and the low personal accomplishment directly leads to the immaturity of social individuals in the handling of interpersonal relations. In the tide of reform, money worship, liberalism, extreme individualism and other unhealthy social trend of thought far-reaching influence, people in dealing with interpersonal relations, the values of fuzzy, even distorted, on the one hand, the word "benefit", many people regard interpersonal relationship as their advanced means of profit, get together for profit, and eventually because of the termination of interests, benefit and scattered; on the other hand, people are used to everything self-centered, advocating extreme freedom, for the personal development, seriously damaged

interpersonal mutual help, mutual aid, mutual love rules.

Third, man and nature are incompatible. In recent years, global problems and ecological imbalance appear frequently, and the relationship between man and nature is seriously unbalanced. On the one hand, people's utilitarian values lead to subjectivity; on the other hand, people's understanding of nature level and vision is limited, causing blindness. Moreover, people are active control of technology, leading to randomness. People's subjectivism and individualism violate the materialist dialectic, destroy the community of man and nature, and ultimately endanger people's own development.

## 1.3 Modern people's demand for tourism is increasing

With the improvement of national quality, people are no longer very interested in the simple tourism, which is only sightseeing, but more pursue the connotation and culture of tourism, rather than the appearance and form of tourism, from the sensory experience to the evolution of the soul seeking. Ordinary tourism and tourist attractions without culture has been gradually eliminated by the society. For example, White Deer Plain Folk Culture Village. Although Chen Zhongshi's 1993, literary masterpiece "White Deer Plain" serves as the cultural support, its cultural volume still cannot support its needs as a tourist attraction, thus leading to decline. It can be seen that culture is of great importance in tourism, and a good culture, a culture with research value and a culture that can have a positive impact on people are more valuable and more worthy of traveling.

Taoist natural philosophy is a huge system, either from political perspective, or philosophy, health perspective, are involved. It′s suitable for the today's tourism industry needs, the present situation of the combination, it also can play a propaganda, develop, inherit the wisdom of the culture, the combination of culture and tourism has a rich theoretical significance and practical significance. This paper is to study the Taoist culture and tourism as the direction, discuss how to combine the philosophical wisdom and tourism, and in the process of its combination, try to ensure the Taoist culture's core idea is not changed, not destroyed, not go wrong in the modern social environment. Make the path of innovation for traditional culture in fusion of modern tourism clearer, it is of great significance to the Taoist culture inheritance and innovation. To summarize the benefits of combination of current Taoist culture and tourism in reality, and provide a theoretical article that can not only protect the development of Taoist culture and tourism, not protect Taoist culture in the way of development, but also promote Taoist culture.

## 2. Research status

For the study of Taoist culture, scholars have different degrees in different disciplines and different disciplines. And in these different fields, it is highly related to the improvement of people's cultural requirements in tourism. And it can also meet the growing needs of people.

## 2.1 Research on the nature of Taoist culture and tourism

The Taoist natural philosophy in the Taoist culture has raised various problems to a philosophical height, and its thoughts can act in many aspects, and the research in this direction has a great correlation with tourism. And it can be said that the core of tourism has the idea of Taoist culture.

Lin Xiyi believed that "traveling is the meaning of pleasure". Lin Yunming said that "the mind is more clear", so the word "traveling" and "travel" contains the meaning of conforming to nature and appropriate behavior, and has the characteristics of super utility, which is very close to Zhuangzi's thought. Zhuangzi's tourism view pays attention to the expression of nature and individual emotion. In the Tao Te Ching, man laws

the earth, the earth, which laws the heaven, the heaven laws the heaven, and the Tao, from the river, and the sea can be the king of the valley. Tourism is the contact between man and nature, and the philosophical thinking of Taoist culture is how man and nature coexist harmoniously. In terms of tourism, it is emphasized that we should conform to nature, advocate nature, and express the feelings of tourism individuals during travel.

Zhuangzi's "Free and Easy Journey" says "riding the truth of heaven and earth, and the defense of the six qi" and "with infinite travel, either and the evil", which shows that there is no restriction on the freedom of travel in Taoist culture. In today's tourism, the core of tourists are to briefly get rid of their original social identity in a certain period of time, that is, in the tourism activities, tourists who were originally a teacher will dilute their identity as a teacher in the tourism activities, and as a traveler for tourism activities. This, in essence, is in common with the freedom that Zhuangzi pursues without any condition. They all have the common characteristics of "swimming" and the pursuit of absolute freedom, psychological and behavioral characteristics, which makes the two closely linked.

2.2 The study of Taoism culture and personality

Taoist culture philosophy, is derived from the natural law of philosophy of Taoist philosophy of humanistic care, the starting point is the naturalistic philosophy, and the foothold is in real life, domestic scholars by analyzing the thought of Taoist "people", to the nature of the family, the existence of people, the development of people have a clear cognition. In the study of the realization of the Taoist life ideal, scholars emphasize the natural nature of human beings, and take the return to nature as the direction of personality shaping efforts. In 1999, Yang Yinlou pointed out in his article "Discussion of Taoist Ideal Personality", that the return of natural nature is the highest ideal personality of human beings.

Through the realization of the value of truth, goodness and beauty of life, we can achieve the ideal state of forgetting things and returning to simplicity. In 2005, Yang Yuhui in the Taoist innate personality and the day after tomorrow personality, put forward the concept of innate personality and the day after tomorrow personality, namely the realization of the ideal personality, from the natural nature against the acquired personality, return to congenital factors leading innate personality, and from the life activities, spiritual emotion, life relationship, the relationship between heaven and man, everyone relationship five aspects discusses the congenital return the day after tomorrow personality realization process. In 2011, in his book, Taoist Philosophy, Zhang Shangren made a systematic summary of the humane concept of Taoism, and put forward the process of Taoist family thought, that is, the realization of personality, which needs to experience such an organic process as the natural nature, the degeneration of human nature and the return of human nature. In 2011, Liu Yimei, in the article "An Analysis of The Ideal Personality of Taoism in the pre-Qin Dynasty", expounded the ultimate pursuit of the Taoist ideal personality model, that is, the perfect realization of "sage", "real person" and "supreme man".

And the Chinese scholars on the study of culture and personality and western scholars, such as Freud's personality development, the combination, you can check different age stage, by learning some parts of the culture, and the corresponding activities, can solve some psychological problems of social personality, and let people and nature back to the state of "harmony", namely the unity of knowledge and action.

About the culture and personality research, combined with tourism, in the process of culture and tourism, more or less to different ages of different degrees and different angles, and the study of culture and personality, to the combination

of culture and tourism plays a very important reference role.

## 2.3Study on Taoist culture and educational practice

When we study Taoist culture and tourism, it is still inevitably necessary to talk about educational practice. If an activity loses its educational significance, then an activity will lose its value and connotation. The research and educational practice can better promote the mutual combination of Taoist culture and tourism, with Taoist culture as the core, tourism as the carrier, and from the outside to the inside to publicize and inherit the wisdom of Taoist culture. And in this, to find a suitable for the integration of road culture and tourism development road.

In Taoist cultivation of life, in 1998, Wang Ze should be in the book of nature and morality: Taoist ethics essence, summarizes the activity of the essence of Taoist life ethics, including years of life consciousness, little adjustment, good enrichment and through the philosophical attitude of death, for the formation of the harmonious personality pattern. In 2011, Li Xinping in the Taoist realm and cultivation of contemporary application value, points out that the ultimate goal of Taoist cultivate one's morality is to achieve the realm of "swim", and to achieve this kind of state, need to adhere to the "yuan thought" the good and evil, the principle of life, need to experience "heart", "sit forget" the virtual static inaction, forget the process of difference.

## 2.4Research on Taoism culture and medicine
In Taoism culture and medical research, there is a high degree of compatibility with health and recreational tourism and tourism activities. Here, it focuses on the psychological aspects of medical research.

For example, Chinese Taoist cognitive therapy is a very representative localized psychotherapy method in China. At present, it is found that Chinese Taoist cognitive therapy is more in line with the thinking characteristics and psychological characteristics of Chinese people, and has certain advantages compared with other therapies. In tourism activities, tourists carry out tourism activities with a psychological state of relaxation and play, which is also in line with the concept of Taoist Zhuangzi of free and easy travel. Then, in the process of tourism activities, the combination of Chinese Taoist cognitive therapy with each other can make tourists benefit more from a tourism activity.

From the physiological aspect, such as the basic theory of traditional Chinese medicine is Yin and Yang, five elements, and the Huangdi Neijing, and the works of the intersection of the Taoist culture, which also shows the wealth of health preservation in the Taoist culture.

## 3.The life wisdom in Taoism culture and can be combined with tourism resources —— Take Qingcheng Mountain as an example

The wisdom of life in the culture and tourism resources are highly compatible, and combining the wisdom of life in the tourism activities, you can get a better tourism experience, such as; in the process of tour words, combining the wisdom of life with scenic spots.

## 3.1The Wisdom of life in the Taoist culture

Taoist culture has rich wisdom in life, and studying its wisdom can better integrate it with tourism organically. As the four major purposes of Taoism, the qing, virtual and weak character comes from the Book of Han. Art and literature annals: then know the grasp to hold the original, qing virtual to self-defense, humble weak to self-sustaining, this king of the south of the art also.

### 3.1.1unmixed

Ethics 15 mentioned; mix xi if turbid; who can turbid with static Xu Qing? Who can live in peace? What he probably means is,

how can a glass of muddy water make it clear? How can you make it become vibrant, if you want to make a cup of muddy and rich impurities of water become clear, with its social conditions at that time, combined with the first step of water plant purification, should be static precipitation. Put the muddy water there, do not shake it, after a period of time and, the water, naturally becomes clear. Good quiet is clear, quiet to go far. It reminds us that every event has a calm gas, impatience is like trying to see the bottom in the muddy water, only after we settle the precipitation, can see the truth of the event.

### 3.1.2void

Simple understanding, can be understood as empty if the valley is empty, the room is empty, so can live people. That is to say, the house is empty because it is empty. Let oneself always be in a state of empty, a state of incomplete, such a state, we can tolerate people, tolerate things, tolerate words, to listen to the advice of others. There is a saying in the Book of History, full of loss, modest benefit, when a person feels complacent about himself, then he will eventually be hit in some aspects, when a person is empty, he will eventually be able to continue to move forward in his own shortcomings. A modest person, with an arrogant person, the former can win more people's joy, we all like to communicate with a modest person, rather than with a arrogant person.

In the fifteen of the book of fifteen, modest, the image for the underground for the mountain, mountain underground, unlike ordinary peaks, bare and ground, but in the underground, not show, to symbolize a person's good virtue, and modesty is sixty-four hang, the only one, each hexagram is auspicious signs, from them, we can also conclude that modesty is not only the embodiment of a person virtue, it is still a person and social progress of a kind of natural condition. In ancient Greek philosophers, Socrates also had a famous saying; admitting his ignorance is the door to wisdom. With our Chinese, the Taoist thought of the virtual word, coincidentally.

### 3.1.3low

Humble is not humble, but to be good at down, water low into the sea, people low king, water convergence to the low, to become the boundless sea, and people low king, is widely win the people, the people of the people of the world. Wood show in the forest, the wind will destroy it. If a person is not good at dealing and likes to show his edge, he will inevitably be hit by others or suffer from failure. For example, Guan Yu in the Romance of The Three Kingdoms, who was headstrong and carelessly lost Jingzhou. The best example of a good position is that Goujian, the king of Yue, slept on brushwood and tasted gall, hid his time, and finally became the five masters of the Spring and Autumn Period. Chapter 28 of the Tao Te Ching also emphasizes this truth; " Know its male, keep its female. Know its white, keep its black. Know its glory, keep its disgrace."

### 3.1.4weak

When we are good at being weak, weak than strong, we try to communicate with us with a soft attitude. If we take the same tough attitude, we may not be able to continue to communicate, which is similar to Dr. Marshall Luxembourg's book Nonviolent Communication. And Chapter 30 of the Tao Te Ching says; " He helps the Lord with the Lord. After the army, there will be fierce years." Those who take the word" Tao " as their thought to assist the king will not win the world with their strong strength, and both the army and the war will bring about bad rewards. This point coincides with Sun Tzu's idea of "in the art of war", so the weak things have more vitality.

### 3.2Tourism resources that can be combined in Taoist culture

In the Taoist culture, there are rich resources that can be used for tourism, and these available resources and the six elements of tourism, including food,

housing, travel, travel, shopping and entertainment, can achieve a highly integrated development.

### 3.2.1Medical health

Medical road is not divided, the ancient practice of the people, are known for immortality; Peng Zu 8 hundred years, Chen Tuan 118 years, Zhang Sanfeng, etc. These situations show that the Taoist culture has made certain achievements in medical health preservation. During the Eastern Jin Dynasty, A Taoist scholar Ge Hong of the Eastern Jin Dynasty, provided inspiration for Tu Youyou, a Nobel Prize winner in China, to study artemisinin. It can be seen that Taoist culture, whether Taoism or Taoism, has a certain contribution to medical care.

For physiological diseases, such as spinal disease, waist pain, in order to solve these problems, there are many ancient "aerobics" can be referred to, such as; Baduanjin, eight diamond gong, Wuqinxi, Taijiquan, etc., playing these fists can effectively help us to relieve the physical pain. And in the process of hitting these fists, it can also play a role in physical fitness, reduce the probability of people getting sick

In psychological activities, learning culture thought, can let us have a better vision, a better attitude, a better way to look at things, can let us with a more gentle attitude to deal with various problems in real life, reduce the high pressure environment of modern society caused all kinds of negative effects on people's psychology, to ensure that we get a good attitude, to treat each kind of negative emotions and alleviate the impact. And studies have shown that 90% of diseases come from emotions, with a dull mood to look at the irritable things, can reduce the occurrence of diseases.

In terms of the physical and psychological combination, the Taoist culture also emphasizes things such as meditation, meditation, promoting human blood circulation and creating a calm mood. Emphasize vegetarian diet, with diet control to obtain a healthy body, a good mood. Such as the valley health.

### 3.2.2literature and fine art

Taoist culture has rich literary and artistic works. In ancient times, there are the painting saint Wu Daozi, and many of his paintings are immortals, which were given the name by Emperor Xuanzong of the Tang Dynasty. In the fine arts, the study of Taoist culture is of great value. In the Tang Dynasty, there is a poet Li Bai. His poems are natural, clever and elegant, and very full of Taoist color. Song dynasty has Su Dongpo, who is afraid of the life, both reflect the debut culture of the spirit of the spiritual life, such as the four famous drama; "hall of eternal life", "peony pavilion" with part of the fairy color, a dream of red mansions also has Jia Baoyu into the fantasy, and this bridge Cao Xueqin is also influenced by the shape of Lao Tzu cosmic sensory description, blind, listen to the state.

In general, the culture of literature and art is not limited to the culture of Taoism and Taoism works, and also can be some other rich Taoist or Taoist culture connotation, including these works, often bring a person a kind of power for life, let a person no longer because of the present pain and feel negative lost, but a more positive and optimistic attitude.

### 3.2.3philosophy

The philosophy of culture, above mentioned qing empty low weak, its for us, work, listen, talk and other aspects, has great significance, and the influence of culture to people is extremely beneficial, it emphasizes the harmony of people, the harmony of man and things, the harmony of man and nature, in the tourism activities, is to pursue the harmony of man and nature.

## 4. Design of Taoism-culture and tourism-related projects

In the design of projects related to Taoist culture and tourism, this article will take Qingcheng Mountain in Sichuan province as the object of investigation, combine the literature, art and philosophy related to

Taoist culture, through pedagogy and different ages to design a super-generational tourism project.

## 4.1 Design ideas and projects for lower grade students

### 4.1.1 Design ideas for lower grade students

Junior students, in the outlook on life, world outlook, values are not fully formed, vulnerable to the environment of external factors and their own thinking is not fully developed, the cognition of the world, the cognition of life, cognition of nature, attention is easy to be distracted, and for a lot of things are fresh, and have a strong need to imitate.

At present, what our society needs is vitality, creativity and enthusiasm. We need a talent who can actively drive the development of various industries in the country. Under this premise, we allow the lower grade students to imitate the excellent part of the Taoist culture to achieve this goal.

According to the culture of the influence of junior students, we in the design of tourism projects, the first to make full use of their curiosity, and then pick out a good imitation object, the good imitation object can cause a positive effect on junior students, then around the imitation object to the related project design.

### 4.1.2 Project design for lower grade students

#### 4.1.2.1 Explain historical stories in Taoist culture allegorical

Qingcheng mountain front mountain has rich Taoism related tourism resources, thanks to China has always been ancestor worship, in general, has a statue of Taoism has its related textual research, such as pure Yang reality for Lv Dongbin, in tourism activities, can add on the deeds, and asked to be vivid and interesting, to stimulate the junior students to imitate nature, by imitating the interpretation of the object to promote their own excellent

growth. And increase the attractiveness of tourism activities to this age group.

#### 4.1.2.2 Imitation of martial arts movements

Qingcheng mountain in addition to the rich Taoist resources, there is a profound martial arts culture, in addition to Wudang, shaolin, in Qingcheng school, such as ancient Chinese martial arts water boxing, and tai chi, etc., can join in the tourism project to watch martial arts performances, a promote the Chinese martial arts culture, and let the idea was deeply rooted in the hearts of the people, let the junior students active nature cast, and not only attract the age, but people of all ages.

#### 4.1.2.3 Imitate your eating habits

In the road culture, pay attention to a diet, and Qingcheng Mountain in the food, Qingcheng four unique, its rich raw materials, exquisite cooking technology, and pay attention to the food culture. Around the scenic area, there are also rich restaurants based on Taoist characteristic diet. According to these available resources, use these special dishes, on the one hand, to let the students of this age group have a good eating habit, and on the other hand, to spread the concept of dietary health spread.

## 4.2 Design ideas and projects for senior students

Senior students compared to the junior students of various cognition and ideas have a certain development, their thinking by concrete image thinking to abstract thinking, and in a certain degree of self-thinking, but still as bright as adolescence, this is also training them to adapt to the society, master the necessary knowledge and skills of future life of a good time.

At this time, students initially have the ability to think independently and have access to the basic parts of Taoist culture. Although it will affect their world outlook and values, it can also exercise their thinking ability and cultivate their ability to treat problems dialectically and distinguish right from wrong.

In addition, for students of this age group, their self-approaching intention will feel significantly enhanced, and they will spontaneously produce more learning behaviors because of curiosity.

Then, in the process of the design of tourism projects, we should take curiosity as the central point, and strive to achieve the goals mentioned above, and also let the senior students have a strong interest in the Taoist culture.

### 4.3 Project design for the senior students

### 4.3.1 Join the study of the basic knowledge of Taoist etiquette in the tourism activities

Taoism as a local religion in China, it has a strong cultural background, the author has observed in Taoism, bowing to the Taoist gesture is close to fifty percent of people do not understand, but the ritual, but this is not the right bowing technique, we learn the basic knowledge of Taoist etiquette is not converted to a religion, but correct errors to protect the Taoist culture correct inheritance.

And for senior students, they are about to enter adolescence, learn etiquette, know etiquette, pass etiquette, with the help of learning Taoist etiquette, can let them have a healthy psychological development.

### 4.3.2 Experience the life of a Taoist priest

As a holy land of Taoism in China, Mount Qingcheng Mountain has rich Taoist tourism resources. The philosophy of Taoism will be not discussed here for the time being, which is not a subject that is easy for senior students to understand. By allowing senior students to experience the life of Taoist priest, the increasingly impetuous psychology of senior students can be removed. The life of a Taoist priest is not daily chanting and meditation, but also martial arts exercises, which is more novel for students living in the city and has a certain attraction.

### 4.3.3 Qingcheng Mountain martial arts experience

Different from the lower grades, the martial arts experience in this stage has changed from watching martial arts performance to the actual learning of martial arts related movements. One is physical fitness, two is the exercise of the mind, and three is virtuous. Students at

### 4.4 Design ideas and projects for adults

The research of adults can temporarily ignore the psychological impact on them, but new and interesting projects, such as the Eight Diagrams, the Plum Blossom and other divination books, should be more thorough in the face of those who intend to study, such as Liu. Based on my observations in other dojo, I found that the biggest attraction for adults is divination. Of course, we should not just seek divination, but through the project to attract adult tourists to understand the culture.

### 4.4.1 divination experience

The study of divination has been handed down since ancient times. There are various methods, including but not limited to Lu Zu Ling sign, copper money asking the divination, and the face is equal. These novelties have extremely attractive effects to adults, and the divination program can be more interesting to attract visitors of this age group.

### 4.4.2 meditation

Adult life pressure is bigger, in yoga activities, can relax, but in Qingcheng mountain meditation experience can do a differentiation competition, preaching in the culture of meditation skills and ordinary yoga meditation skills, which promotes Chinese traditional culture, and to help adults get a good physical condition.

### 4.4.3 Taoist life experience

Make full use of the rich Taoist places in Qingcheng Mountain, to experience the life of Taoism on the field, through the independent development of adults learning, people can more effectively learn to understand the Taoist culture. Start with

the life form, and then let it dig deep into its philosophical ideas in a spontaneous way.

## MAIN RESULTS

4 major cities（Chengdu, Deyang, Mianyang, Suining) of 9 Taoist tourism temples of Sichuan, (Chengdu Qingyang Taoist Temple, Deyang Jade Emperor Temple, Mianyang Jade Emperor Temple, Mianyang Yuntai Temple, Mianyang Jinguang Dong Temple, Suining Changle Temple, Suining Wanshou Temple, Suining Mountain Jinhua Temple, Suining Mountain Gaofeng Temple (sites of worship of the Taoist god, the ancient philosopher, Lao Zi), 4 factors that influence the development of integration of Taoist culture and Tourism have been analyzed, Age and Taoist Belief, Location, Tourism Popularity, Taoist Culture. It shows the 4 factors has strong impact on the Taoist tourism development. (Table 4 and Illustration 1) .

The author examined the book Dao De Jing, offers the proposal of that 4 wisdom elements of Taoist culture could be used to integrate tourism business, which are unmixed,void,low,weak(Table 1). 3 aspects of field could be combined, those are Medical health, Literature and fine art, Philosophy. 3 types of programs could be designed according to tourist age ranges.



**Illustration 1** Suining Mountain Gaofeng Temple

**Table 1** The wisdom in Taoist culture

| The Wisdom in Taoist culture | Unmixed | Void | Low | Weak |
|---|---|---|---|---|
|  |  |  |  |  |

**Table 2** Tourism resources that can be combined in Taoist culture

| Tourism resources that can be combined in Taoist culture | Medical health | literature and fine art | Philosophy |
|---|---|---|---|

**Table 3** Project design for students and adults

| Project design for lower grade students | Explain historical stories in Taoist culture allegorical | Imitation of martial arts movements | Imitate your eating habits |
|---|---|---|---|
| Project design for the senior students | Join the study of the basic knowledge of Taoist etiquette in the tourism activities | Experience the life of a Taoist priest | Qingcheng Mountain martial arts experience |
| Design ideas and projects for adults | divination experience | Meditation | Taoist life experience |

**Table 4** Elements that influence the integration of Taoist culture and tourism

| Places/ Influence Elements | Chengdu Qingyang Taoist Temple | Deyang Jade Emperor Temple | Mianyang Jade Emperor Temple | Mianyang Yuntai Temple | Mianyang Jinguang Dong Temple | Suining Changle Temple | Suining Wanshou Temple | Mountain Jinhua Temple | Mountain Gaofeng Temple |
|---|---|---|---|---|---|---|---|---|---|
| **Age Range and Taoist Belief** | Younger tourist, low belief | Young generation, touring | Middle age tourists, pure belief | Mid-aged, touring & pure belief | Younger age, touring and belief | Older generation, belief | Closed, due to develop | Young and old visitor, touring & belief | Young and old visitor, touring& belief |
| **Location** | Downtown | Mountain, not far from downtown | Mountain, a little far from downtown | Mountain, far from downtown | In the cave of mountain, far from downtown | Mountain, not far from downtown | Mountain, not far from downtown | Mountain, not far from downtown | Mountain, far from downtown |
| **Taoist Culture** | History temple, worship, food,draw lots,fortune-telling | Modern temple, food,worship | Modern temple, worship | Ancient temple,architecture,worship, food | Modern temple, worship, natural view | Modern temple, worship, draw-lot | Modern temple | Ancient temple, worship, natural view | Ancient temple,architecture,worship, food |

| Tourism Popularity | Medium | Low | Low | Less medium | Low | Low | None | Medium | Medium |
|---|---|---|---|---|---|---|---|---|---|

## CONCLUSION

4 major cities of 9 Taoist tourism temples of Sichuan have been analyzed, 4 wisdom elements of Taoist culture have been proposed to integrate tourism business, 3 aspects of field have been suggested to be combined, 3 types of programs have been designed according to tourist age ranges. The author only offers the proposal from the tourism destination view, future studies could do it from tourist part. Through the above project design, Tourist agent could put it into practice and it can provide a new reference idea for the mutual promotion of Taoist culture and tourism development.

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