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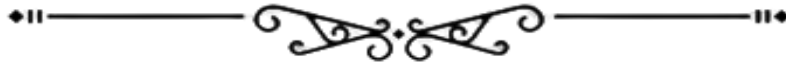**17TH - 18TH**
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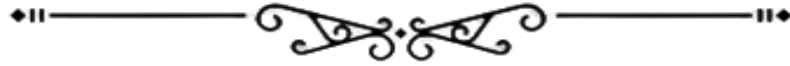**Publicity and Communication Committee**

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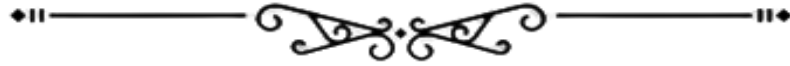
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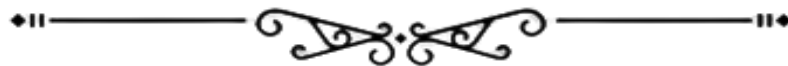Mr. Iqmal Nor Bin Mohd Noh

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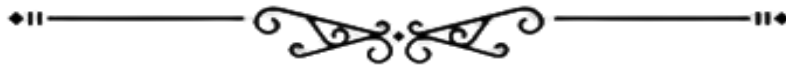Sr Gs. Dr. Othman Bin Zainon

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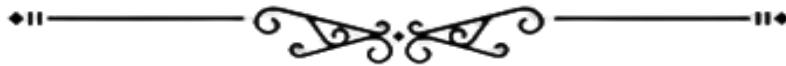
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REAL ESTATE

IS THE INDUSTRY READY? ARTIFICIAL INTELLIGENCE-ASSISTED SPACE MANAGEMENT IN FACILITIES MANAGEMENT

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ABSTRACT

Facilities management involves overseeing a wide range of tasks, from managing building systems to maintaining physical spaces. With the growing availability of artificial intelligence (AI) technology, there is an opportunity to improve space management in facilities management using these tools. However, the adoption of AI in facilities management is still in its early stages, and several factors need to be considered before implementing AI-assisted space management. This study aims to promote the adoption of AI technology in facilities management. Through a literature survey, this study investigates the current state of AI technology in facilities management. Specifically, it focuses on three objectives to achieve this goal. First, the study assesses the perceived benefits of implementing AI-assisted space management. Second, it identifies the perceived challenges in implementing AI-assisted space management. Last, the study explores the readiness to adopt AI-assisted space management practices. The results will provide valuable insights into the industry's readiness for AI-assisted space management, identifying potential barriers to adoption. These findings will be useful for AI vendors, facilities management companies, and other stakeholders in the industry who are considering the implementation of AI-assisted space management tools. This study will contribute to the broader discussion on the use of AI in facilities management and help shape the future of space management practices.

Keywords: Facilities Management, Artificial Intelligence, Space Management, Healthy Building

1.0 INTRODUCTION

ARTIFICIAL INTELLIGENCE (AI) can significantly improve space management in facilities management. Organizations may maximize space use, improve operational efficiency, and improve the overall tenant experience by leveraging AI algorithms and data analytics (Mazhar et al., 2023). However, the industry's preparation for AI-assisted space management depends on several things (Jan et al., 2022).

According to Douglas in 1996, space planning and management are critical components of any facilities' management system. As a result, facility

management is critical for long-term development (Lai et al., 2022). In 2018, Davenport reported Scandinavian countries began experimenting with Artificial Intelligence in Facilities Management almost a decade ago, which shows a perceived urgency shown by the region. Data security and privacy were among the difficulties they encountered (Shahzad, 2022).

The Stress Factor

Cities are important variables in long-term sustainability because they currently house more than half of the world's population and will do so soon. Families in modern cities live in close quarters, putting their health and wellness at risk (De Guimarães et al., 2020). Residents of Kuala Lumpur are also becoming more susceptible to urban stress and mental fatigue because of the city's rapid urbanization and previous poor city planning (Wei & Rahman, 2022). The people seek peace and tranquility to escape from their hectic environment (Mohamad & Hussein, 2021).

Space Management in View

Space management is equally important in facilities management since it assures little to zero waste, proper use of space for the right purpose, increases employee satisfaction, and supports workforce welfare (Weeks & Leite, 2022). Ryan and Browning (2020) revealed that large organizations waste 10 billion GBP annually due to office space waste, and that 42% of commercial space worldwide is underutilized, emphasizing the importance of facilities management.

According to Henry Butcher Malaysia's annual property market study, the glut of office space in Klang Valley will persist and may intensify with impending big office projects (Woo & Khoo, 2023). Although the retail property segment regained momentum in 2022, it is likely to encounter some hurdles in 2023 because of inflation, a personnel shortage, and an increasing supply of retail floor space with the impending new malls.

Market attitudes and worker layoffs can also affect the business sector. Companies are cutting off tens of thousands of people in Manhattan, which is dealing with a post-pandemic slowdown (Auer, 2022). According to real estate brokerage firm Savills, 348 million square feet of office space are available across the United States, nearly double what was available prior to the pandemic (Wong & Day, 2023).

AI In Facilities Management

AI in facilities management has revolutionized the way organizations optimize and streamline their operational processes (Baduge et al., 2022). By leveraging advanced algorithms and data analytics, AI enables real-time monitoring and predictive maintenance of critical systems, such as HVAC, lighting, and security (Sleem & Elhenawy, 2023). AI-powered facility management systems can detect anomalies, identify potential issues before they occur, and automatically schedule maintenance tasks, leading to improved energy efficiency, cost savings, and enhanced occupant comfort (Himeur et al., 2023).

Additionally, AI-driven analytics provide valuable insights into space utilization, enabling better decision-making in terms of workspace design, resource allocation, and overall facility optimization (Mehmood et al., 2019). With AI, facilities management has become more proactive, efficient, and data-driven, enabling organizations to create smarter, more sustainable, and user-centric environments (Mazhar et al., 2023).

Statistics show that energy wastage in commercial buildings is around 30% each year. Energy efficiency will be a crucial concern if organizations are to meet sustainability standards as lowering carbon footprints becomes a corporate issue (Baduge et al., 2022). Hybrid

working spaces are also quickly becoming a trend, causing the need for effective space management, which AI can better quantify by eliminating the human error factor (Himeur et al., 2023).

Organizations require infrastructure to implement AI-assisted space management effectively (Rafsanjani & Nabizadeh, 2021). This comprises dependable network access, data storage capabilities, and computational capacity to support the processing needs of AI algorithms (Baduge et al., 2022). The availability and scalability of such infrastructure may differ among enterprises and industries (Shahzad, 2022).

To produce accurate predictions and suggestions, AI systems require enormous amounts of high-quality data. This data may include occupancy patterns, usage rates, environmental variables, and user preferences for space management (Himeur et al., 2023). To properly train AI models, organizations must have access to comprehensive and dependable data sources (Baduge et al., 2022). To gain useful data, data collecting technologies such as sensors or Internet of Things (IoT) devices may be required (Sleem & Elhenawy, 2023).

As AI systems handle and analyze sensitive data about facilities and people, it is critical to ensure data privacy and security. Organizations must have rigorous measures to preserve individuals' privacy and prevent unwanted access to sensitive information. It is critical to follow all applicable data protection regulations. The Personal Data Protection Act 2010 (PDPA 2010) governs data protection in Malaysia.

Building management systems (BMS), energy management systems, and maintenance systems are all common components of facilities management. AI-assisted space management should integrate with these systems to deliver holistic insights and automate actions (Abd Hamid et al., 2022). Integration

difficulties such as data compatibility, interoperability, and legacy system limits must be addressed to integrate AI-assisted space management with all common components of facilities management, as stated by Himeur et al. al., 2023).

Adopting AI-assisted space management causes businesses' embracing of technology improvements and a clear vision for exploiting AI (Abd Hamid et al., 2022). This involves providing training and upskilling to individuals for them to operate and comprehend AI technologies successfully. Businesses must be ready with the cash, resources, and key stakeholder commitment to drive AI implementation (Mehmood et al., 2019).

Using AI in space management presents ethical and social considerations. Organizations must handle issues such as data ownership, transparency of AI systems, and potential decision-making biases (Werder et al., 2022). It is critical to guarantee that AI systems are fair, accountable, and adhere to ethical standards (Rafsanjani & Nabizadeh, 2021).

While AI-assisted space management has great promise, the industry's readiness varies. Based on their technological maturity, available resources, and willingness to adopt AI, certain businesses and sectors may be better prepared than others (Khan et al., 2023). Thoroughly examining these elements and overcoming any problems is critical to ensure successful deployment and maximize the benefits of AI in facilities management (Abd Hamid et al., 2022).

Regulatory Initiatives and Governance

The Malaysia Board of Technologists, a Statutory Body within MOSTI established by the Technologists and Technicians Act 2015 (Act 768), has also urged that modern technical features must ensure that structures are always safe. By merging with this modern

technology, it will also provide value to building upkeep and conservation. The Internet of Things (IoT), Big Data Analytics (BDA), and additive materials are among the technologies deployed. By merging advanced technologies, we can explore more economic potential. This is because of the process chain involved (MBOT, 2021). Finally, buildings and the field of facilities management will benefit from this (Werder et al., 2022).

This paper is also necessary to develop a specific set of legislation for governing AI in Malaysia (Abd Hamid et al., 2022). The Personal Data Protection Act 2010 includes data protection principles such as disclosure, security, retention, and data integrity, which can be used as a foundation to guide the responsible management of data in relation to the development of AI (Ayamany, 2023).

there are also regulations that apply to the use or misuse of technology, such as the Communications and Multimedia Act 1998, as well as copyright laws to protect software intellectual property and consumer protection laws, such as the Consumer Protection Act 1999 and the Consumer Protection (Electronic Trade Transactions) Regulations 2012, that can protect consumers' rights in AI technology (Ayamany, 2023; Shin Associates, 2023; Morden, 2023).

Besides current regulations, the Malaysian Ministry of Science, Technology, and Innovation developed the Malaysia AI Roadmap in 2021 with the goal of regulating and managing the development and implementation of AI technologies in Malaysia until 2025 (MOSTI, 2022).

Research Gaps and Justification

As it turns out, the research gap consists of at least four interconnected issues which will be discussed in detail. Researchers have developed 20 AI techniques for energy consumption and comfort control in buildings (Sleem &

Elhenawy, 2023). However, using AI technology for building control is still a work in progress, as it demands a substantial amount of real-world data, which is lacking in the construction and energy sectors (Khan et al., 2023). The performance of AI-based control is not yet fully satisfactory (Shahzad, 2022; Mazhar et al., 2023).

Overall, the ability of AI in space management within facilities management to optimize space utilization, improve occupant experience, reduce costs, enable data-driven decision making, enhance safety and security, and provide scalability and adaptability to changing facility needs is the justification for implementing AI in space management within facilities management. These advantages contribute to more efficient and effective facility management methods, resulting in greater operational performance and an overall better facility environment.

Objectives

Three objectives are core to this paper:

Objective 1: To assess the perceived benefits in implementing AI-assisted space management.

Objective 2: To identify the perceived challenges in implementing AI-assisted space management.

Objective 3: To explore the readiness to adopt AI-assisted space management practices.

Novelty

It has been noted that the scope of the paper is niche and there is a glaring lack of regulatory initiative and governance as AI is still in its infancy in Malaysia (Rehman et al., 2022). There is great potential and value for further research in this field. Furthermore, with the emerging technologies such as 5G (Abd

Hamid et al., 2022), priority should be placed on this article.

According to the Global AI Index, Malaysia is ranked in 44th place with an overall score of 19.6, receiving low points in talent, research, development, and commercial aspects. This is way behind third-placed Singapore with a score of 50, as well as second-placed China with a score of 61.5 (Chong, 2023). Critically assessing this situation, more commitment must be shown in order for us to move forward (Abd Hamid et al., 2022; Rehman et al., 2022).

By achieving and answering the objectives, the AI-assisted space management system can significantly enhance the efficiency, productivity, and cost-effectiveness of facilities management operations (Shahzad, 2022).

The remaining chapters are Chapter 2.0 Methodology, which describes the literature survey in relation to the present study through keywords, Chapter 3.0 Main Findings, which discusses the findings based on the three objectives set. Chapter 4.0 Conclusion discusses the summary of the study and the way forward.

2.0   METHODOLOGY

To determine the readiness of the industry for AI-assisted space management in facilities management, a literature survey can provide an overview of existing research and industry publications related to AI-assisted space management in facilities management, using the keywords listed in Table 1. This helps researchers understand the state-of-the art, identify gaps in knowledge, and gather insights into the challenges and opportunities in the industry. It also allows for a comparison of different approaches and technologies.

By following this method and studying the literature critically, organizations can leverage AI to optimize space management practices, enhance

operational efficiency, and achieve their facility management objectives more effectively.

Table 1 Research Keywords for Literature survey

No.	Keyword
1	Facility management
2	Space Planning
3	Spatial Digitalization
4	Artificial Intelligence
5	Machine Learning
6	Optimization
7	Deep Learning
8	Data Mining

3.0   MAIN FINDINGS

The literature survey on the readiness of the industry for AI-assisted space management in facilities management provides an interesting overview of existing research and publications on the topic. It synthesizes the findings and insights from various sources to assess the current state of readiness in the industry.

The analysis based on **Objective 1**, "To assess the perceived benefits in implementing AI-assisted space management", yielded the following findings.

Optimising Space and Cost

AI-assisted space management presents a game-changing solution for optimizing space utilization, especially in densely populated urban areas (Almusaed et al., 2023; Mazhar et al., 2023). By analyzing space usage patterns and intelligently allocating resources, AI ensures that available space is utilized efficiently, making it a crucial tool in maximizing limited space (Himeur et al., 2023). This leads to substantial cost savings for businesses and organizations as wasted space is minimized, resulting in reduced expenses related to rent, utilities, and maintenance (Shahzad, 2022). AI's ability to identify areas of inefficiency and

suggest cost-saving measures further enhances its value in promoting financial prudence (Sleem & Elhenawy, 2023).

Improved Productivity

Besides cost savings, AI-powered space management significantly improves productivity within organizations. By streamlining workflows, automating repetitive tasks, and offering real-time data insights, employees can focus on core responsibilities while AI handles routine space management functions (Khan et al., 2023). This not only boosts overall productivity but also enhances operational efficiency, allowing businesses to operate smoothly and with greater agility. Furthermore, AI contributes to enhanced safety and security by monitoring spaces in real-time, identifying potential hazards, and managing crowds during events or emergencies, ensuring the well-being of occupants and visitors alike (Mehmood et al., 2019).

Personalised User Experience

Moreover, AI's ability to personalize user experiences in public spaces like shopping malls, museums, and airports leads to higher customer satisfaction and increased visitor engagement (Almusaed et al., 2023). Through AI-driven recommendations based on individual preferences and behaviors, visitors feel more connected and catered to, fostering loyalty and positive brand experiences (Mehmood et al., 2019). Additionally, AI's role in energy efficiency cannot be understated. By controlling heating, ventilation, and air conditioning systems based on occupancy and environmental conditions, AI minimizes energy waste and lowers operational costs, contributing to environmental sustainability (Rafsanjani & Nabizadeh, 2021). AI also plays a crucial role in predictive maintenance, anticipating equipment failures and maintenance needs, leading to proactive measures that extend the lifespan of assets and reduce costly downtime (Shahzad, 2022).

Furthermore, AI-driven data insights empower decision-makers with valuable information for space planning, expansions, and other strategic moves (Khan et al., 2023). This data-driven decision-making approach optimizes resource allocation and future-proofs organizations by ensuring well-informed choices (Mazhar et al., 2023). AI's contribution to sustainability is equally significant as it monitors resource consumption, waste generation, and carbon footprints, encouraging environmentally friendly practices that mitigate ecological impact (Rafsanjani & Nabizadeh, 2021). Lastly, AI enables space customization to meet specific needs. In flexible workspaces, AI-powered systems can adapt space configurations, such as desks and seating arrangements, based on staff requirements for a given day, fostering a dynamic and efficient work environment (Mehmood et al., 2019).

The literature analysis based on **Objective 2**, "To identify the perceived challenges in implementing AI-assisted space management", yielded the following findings.

Organizational Readiness and Change Management

The literature emphasizes the importance of organizational readiness and change management for successful implementation of AI-assisted space management. This includes having a clear vision and strategy for AI adoption, securing leadership commitment, and investing in employee training and upskilling (Almusaed et al., 2023). Organizational culture, resistance to change, and employee acceptance of AI technologies are identified as factors that can impact readiness and implementation success (Rafsanjani & Nabizadeh, 2021).

Ethical and Social Implications

The literature recognizes the ethical and social implications associated with AI-assisted space management (Khan et al., 2023). Privacy concerns, data security,

transparency of AI algorithms, and potential biases in decision-making are highlighted as critical considerations (Mora-Cantallops et al., 2021). The need for ethical guidelines, regulatory compliance, and responsible AI practices is emphasized to ensure the ethical and fair implementation of AI in space management (Werder et al., 2022).

Overall, the literature survey indicates that the industry is progressing towards readiness for AI-assisted space management in facilities management. While some organizations have made significant strides in adopting AI technologies and infrastructure, challenges related to data availability, integration, and change management still exist (Werder et al., 2022). Further research and practical implementations are needed to address these challenges and facilitate the industry's readiness for AI in space management.

Data Availability and Quality

The availability and quality of data play a crucial role in AI-assisted space management. The literature suggests that organizations are increasingly adopting data collection mechanisms, such as sensors and IoT devices, to gather relevant data on occupancy patterns, utilization rates, environmental conditions, and user preferences (Sleem & Elhenawy, 2023; Mazhar et al., 2023). However, data silos, data privacy concerns, and data quality issues are still prevalent challenges that need to be addressed for effective implementation of AI in space management (Shahzad, 2022).

Integration with Existing Systems

Integrating AI-assisted space management with existing systems, such as building management systems and maintenance systems, is an important consideration (Mehmood et al., 2023). The literature highlights the need for seamless integration to leverage the full potential of AI (Almusaed et al., 2023). However, compatibility issues, data interoperability

challenges, and legacy systems can pose obstacles to integration efforts (Werder et al., 2022; Mazhar et al., 2023). Standardization and interoperability frameworks are suggested as potential solutions (Shahzad, 2022).

Space Management Issues

While the industry is progressing towards readiness for AI-assisted space management, there are still challenges to overcome. Organizations need to address infrastructure limitations, data availability and quality issues, integration challenges, and change management aspects to fully leverage the potential of AI in facilities management (Rafsanjani & Nabizadeh, 2021; Khan et al., 2023). Further research, collaboration, and practical implementations are necessary to enhance the industry's readiness for AI in space management (Mehmood et al., 2019; Abd Hamid et al., 2022). Several major space management issues had been identified and summarised in Table 2.

Table 2 Major Space Management Issues

MAJOR SPACE MANAGEMENT ISSUES			
Space Planning	Space Utilisation	Space Optimisation	Assets Arrangement

The literature analysis based on **Objective 3**, "To explore the readiness to adopt AI-assisted space management practices", yielded the following findings:

Awareness and Understanding

The literature suggests that there is growing awareness and understanding of AI-assisted space management in facilities management (Abd Hamid et al., 2022). Research studies highlight the potential benefits of AI in optimizing space utilization, improving energy efficiency,

enhancing occupant comfort, and streamlining operations (Almusaed et al., 2023; Mazhar et al., 2023). However, there is a need for further education and knowledge sharing to ensure a deeper understanding of AI concepts and technologies among professionals in the industry (Baduge et al., 2023).

Infrastructure Readiness

The readiness of the industry in terms of infrastructure varies (Abd Hamid et al., 2022). Some organizations have invested in the infrastructure, including network connectivity, data storage, and computational resources, to support AI-assisted space management (Sturgeon, 2021). However, others may face challenges in terms of limited technological capabilities and resources (Shahzad, 2022). The literature emphasizes the importance of scalable and robust infrastructure to handle the data processing requirements of AI algorithms (Khan et al., 2023).

4.0   CONCLUSION

The industry's readiness for AI-assisted space management in facilities management can be determined based on the findings. There are interoperability issues in the exchange of information among facility management systems, which require further research. The current disjointed systems cause inefficiencies and process breakdowns.

AI can change facility and space management by making processes simpler, enhancing efficiency, and providing more precise insights. As AI continues to advance, we can expect to see even more creative applications in these areas in the future. Ultimately, AI has the potential to revolutionize the way we manage facilities and spaces.

Future work should aim to develop standardized methods for integrating data sources, automate real-time data transfer, and advance virtual and augmented reality technologies. The study's major

contribution is leveraging Construction 4.0 technologies such as IoT, big data, AI, robotics, and digital twin. The goal is to merge approaches and technology into a new, deep digital twin for an inventive future in architecture, engineering, construction, and facility management. This will promote intelligent and sustainable facility management processes.

5.0   ACKNOWLEDGEMENT

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AN ANALYTICS READINESS FRAMEWORK FOR COST-EFFECTIVE DECISION-MAKING IN BUILDING MAINTENANCE

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ABSTRACT

A significant aspect that affects building maintenance is cost. As buildings age, cost-effective strategies are required to ensure they are not too expensive to own, operate, and maintain. Therefore, cost-effective decisions must be made to improve the maintenance process. In building maintenance, facility managers tend to depend heavily on their intuition and experience in their decision-making process. While intuition and experience play an important role, depending on them alone poses a risk. Augmenting them with a more rational decision-making system involving statistical analysis is vital. The importance of analytics to maintenance cannot be overemphasized. Through analytics, maintenance can be viewed from a methodological and technological perspective and can be applied to predict scenarios like aligning maintenance needs with projected growth. While several studies have critically examined the benefits of analytics in maintenance (termed maintenance analytics) and the tools required to harness data, there is still a lack of studies determining whether these facility managers and other building decision-makers are ready for analytics. This study looks to develop a theoretical framework identifying analytics readiness factors required for cost-effective decision-making. Three frameworks were chosen to be reviewed. After a review of these frameworks, the analytics readiness factors identified are intent to adopt, perceived usefulness, perceived ease of use, relative advantage, complexity, compatibility, top management support, organizational readiness, organization size, mimetic pressure, coercive pressure, and normative pressure. While the factors identified for cost-effective decision-making variables are maintenance policies, budget, building condition, communication, maintenance strategy, processes, building inspection, cost estimation, and cost management. The study concluded with a framework developed to guide maintenance analytics readiness for cost-effective decision-making.

Keywords : Analytics readiness, Cost-effectiveness, Decision-making

1.0 INTRODUCTION

Maintenance is needed about 90% of the time throughout the building lifecycle, accounting for about 75% of the costs (Olanrewaju, Wong & Lim, 2022). Studies have revealed that building operation and maintenance costs are higher than the initial construction cost (Morgado et al., 2017). A building service life is estimated to last 50 years, and maintenance constitutes 75–80% of the lifecycle costs, while the initial design and construction costs take only 20–25% (Faqih & Zayed, 2021).

The existing state of building maintenance is of great concern because of the complex maintenance process and limited resources available (Salzano et al., 2023). Studies have revealed that maintenance is carried out ineffectively, leading to high costs, delayed repairs, and reduced lifecycle (Palis & Misnan, 2018). This ineffectiveness results from the reactive approach that facility managers usually default due to maintenance costs (Ali, 2009). To manage the available resources, facility managers have resorted to using intuition to disperse funds. As a consequence, they focus on cost minimization, which does not necessarily guarantee effectiveness (Al-Najjar & Kans, 2006). Maintenance decisions should be based on cost-effectiveness and not minimization.

A brief description of cost-effectiveness is getting value for money (Al-Najjar & Kans, 2006). Value is an abstract concept because, unlike cost, it cannot be quantified or estimated (Lateef, 2009). However, cost-effectiveness is achieved by evaluating the costs and benefits of a specific program, process, or policy to determine whether it efficiently uses resources (Eichler et al., 2004). When maintenance resources are effectively allocated, it creates a balance between cost minimization and building performance (Krstić & Marenjak, 2017).

Cost-effectiveness is closely tied to decision-making because maintenance decisions significantly influence resource allocation, task prioritization, and building performance (Al-Najjar & Kans, 2006). Studies have shown that making maintenance decisions is challenging for facility managers (Chua et al., 2015). This is because of the constant pressure to reduce building operation costs and maximize efficiency and productivity, forcing them to balance building requirements against financial limitations (Ensafi & Thabet, 2021). Furthermore, Ensafi et al. (2023) observed that the major reason why facility managers struggle with decision-making is because of inconsistency in prioritizing work orders, poor data management, insufficient information, cognitive workload, and inconsistency in data collection.

Although building maintenance involves many components and equipment with a large volume of associated data, the maintenance practice faces challenges like data loss, time wasted during information search, lack of interoperability, and data inconsistency (Yang & Bayapu, 2019). Maintenance requires an approach with access to accurate and reliable data about building systems and components (Sadeghi et al., 2018). A lack of adequate decision-making approaches and maintenance planning can lead to high maintenance costs, influencing the maintenance quality (Islam et al., 2019). Making cost-effective decisions requires integrating, analyzing, and utilizing big data databases (Al-Najjar & Kans, 2006). Therefore, analytics readiness is a necessity for building maintenance.

Analytics readiness is an organization's willingness to embrace and implement analytics (Auh et al., 2022). It refers to the ability to collect, manage, analyze, and interpret data for decision-making purposes (Ijab et al., 2019). Analytics readiness goes beyond possessing technological support, and there are other factors within and outside the organization (Auh et al., 2022; Gürdür et al., 2019; Ijab et al., 2019; Kalema & Mokgadi, 2017;

Salman et al., 2022; Sulistyowati et al., 2021). Therefore, all these factors must be considered when deciding on a maintenance strategy.

The arrival of the fourth industrial revolution led the 21st century to experience a rapid transformation in technology, industries, and societal processes and patterns because of interconnectivity and smart automation (Devezas & Sarygulov, 2017). As a consequence, it blurs the borders between the physical and digital worlds. This fourth industrial revolution has brought many technological advances that have impacted various industries, including the building industry (Dallasega et al., 2018). Unfortunately, the building industry has been branded rigid and slow in responding to change (Bouras et al., 2016). The building industry has been sluggish in adopting new technologies and practices compared to other industries. This is because the building industry is primarily project-based, with multiple stakeholders and professionals and lengthy supply chain processes. There is also the problem of high cost, the industry's conservative nature, and reluctance to take new risks, which inadvertently affects analytics readiness.

Although several studies have highlighted the benefits of analytics to building maintenance, there is still a need to ensure readiness in implementing analytics. This study looked to achieve this by developing a maintenance analytics framework identifying factors required for cost-effective decision-making. This was done by reviewing established frameworks on analytic readiness, and cost-effective decision-making.

REVIEW OF FRAMEWORKS

Technology-Organization-Environment (TOE) Framework

This TOE framework was developed to guide organizations in adopting innovation

(Tornatzky & Klein, 1982). Tornatzky and Klein (1982) identified three factors of influence, namely the technological, organizational, and environmental factors, and examined how these factors influence the adoption of technological innovation. This makes it practical to understand the ability of an organization to implement and utilize data analytics effectively (Low et al., 2011). Furthermore, this framework is important because analyzing the contingency variables that influence organizational decisions is one of the most comprehensive approaches to readiness (Wisdom et al., 2014).

The technological dimension assesses how prepared an organization is to adopt new technology. This is because of the confidence and optimism that adopting technology will make tasks more manageable. Analytics is important because it improves efficiency and provides directions for enhancing the performance and quality of work (Flavián et al., 2022). Parasuraman (2000) presents this index as an eagerness to adopt new technologies to enhance work efficiency. Existing literature has described readiness as the workers' technical preparedness for technological acceptance, and numerous studies have been undertaken. The variables in the technological dimension that have been identified from past studies are compatibility, perceived risk, complexity, infrastructure, relative advantage, skills, security, data management, reliability, and data scalability (Alojail, 2022; Ghaleb et al., 2021; Ijab et al., 2019; Katebi et al., 2022; Lutfi et al., 2022; Muhammad, 2022; Salman et al., 2022).

The organizational dimension places great emphasis on the structural components of an organization, like size, resources, communication, organization structure, and the level to which they are centralized and formalized (Ghaleb et al., 2021). Organizational structure greatly influences analytics readiness and affects employee interaction. Oliveira et al. (2014) posit that the structure of an organization influences

technological adoption. This implies that a flatter or decentralized structure is more open to using cutting-edge technology than other organizations. This increases the organization's readiness to implement analytics in their daily tasks. The organization will achieve this because they embrace new technologies that improve coordination and communication within and outside the organization (Venkatesh et al., 2012). The organization's adopting analytics characteristics are also crucial in determining analytics readiness. This includes the organization's size, structure, culture, and resources. Larger organizations may have more resources to invest in analytics capabilities, while organizations with a more flexible structure may be better suited to adopt analytics quickly. A culture that values data-driven decision-making can also contribute to analytics readiness.

The environmental dimension focuses on the industry characteristics, constraints, opportunities, practices, and policies that impact innovation adoption in decision-making (Oliveira et al., 2014). External challenges like the competitive market and customer demand can influence decision-makers to respond to the environment, imitate industry leaders, and retain standard organizational practices. Zorn et al. (2011) revealed that external pressures enable the advancement of technology adoption. The external factors influencing the adoption of analytics also play a role in analytics readiness. For example, economic factors, such as the cost of analytics software and potential return on investment, can influence adoption. In addition, social factors, such as employee acceptance of analytics and customer demand for data-driven products and services, can also impact readiness. Finally, regulatory aspects, such as data privacy regulations, can also affect the adoption of analytics.

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) proposed by Davis (1985) was based on the Theory of Reasoned Action (TRA) of Fishbein and Ajzen (1980). TAM has been applied in many studies to investigate innovation adoption (Shin et al., 2018). This model assesses user attitude and acceptance of new technology (Nikou, 2019). Perceived usefulness and perceived ease of use are the main factors influencing the decision to use or adopt a technology (Davis, 1985). The term' perceived usefulness' relates to an individual's perception that employing technology will improve job productivity or effectiveness. While 'perceived ease of use' describes an individual's feelings about using a particular technology. According to the TAM, the adoption rate of the technology will increase either increase performance or effectiveness if the user experiences minimal difficulty during use (Davis, 1985; 1989). Although TAM is a robust model, studies have suggested that this model can be expanded by adding other organizational and technological variables (Venkatesh et al., 2012). This model will be used as a foundation to integrate other factors influencing analytics readiness in building maintenance.

Intention to Adopt

Based on the TAM, readiness depends on the intention to apply a specific technology, which is determined by the perceived utility and usability of the system (Davis, 1985). In other words, intention is the culmination of the decision-making process. It measures the willingness to engage in behavior that indicates readiness (Ajzen & Driver, 1991). Through TAM, intent to adopt can be assessed from an individual and organizational level. At the individual level, TAM suggests that the perception of usefulness and ease of use of technology will affect the intention to adopt it. An individual's attitude towards a technology eventually influences the intention to utilize or embrace it, which culminates in its actual implementation, considering both social and individual views of TAM. Walker (2011) also mentioned human behavior as an

important consideration in decision-making, particularly when industrialization techniques are used. At the organizational level, the aggregate of perceptions and intentions of individuals within the organization will influence the overall adoption and acceptance of technology within the organization. An organization is more likely to adopt a technology if a sizable portion of its workforce finds it helpful and simple to use.

Perceived Usefulness

According to TAM, perceived usefulness refers to how well individuals understand the performance and efficiency improvements gained from using a specific technology (Davis, 1985). Utilizing maintenance analytics offers several benefits, such as improved decision-making, lower maintenance cost, regulating and prioritizing maintenance work, and ensuring maintenance is carried out effectively (Dutta et al., 2020; Gunay et al., 2019). In this research, perceived usefulness refers to understanding the benefits of applying maintenance analytics. It indicates how building maintenance decision-makers know the advantages of maintenance analytics. This variable is crucial because of the intention to adopt analytics asides from the ease of use (Davis, 1985).

Perceived Ease of Use

The TAM views perceived ease of use as understanding the effort needed to use a specific technology (Davis, 1985). For this research, perceived ease of use refers to the difficulty in learning, managing, and implementing analytics (Davis, 1985). Based on the TAM, perceived ease of use directly or indirectly affects the intention to adopt through perceived uselessness (Shin et al., 2018). This implies that when the users find it difficult to implement analytics, they comprehend its advantages less. Therefore, when facility managers and building decision-makers find it easy to implement and use analytics, it positively influences their understanding

of it, resulting in analytics readiness.

Maintenance Cost Planning Framework

Le et al. (2018) developed the maintenance cost planning framework. This framework was developed from three cost prediction and estimating models. It began by assessing the maintenance and operation cost model by Krstić and Marenjak (2017). This model used the historical data from university buildings to predict maintenance costs over periods using multiple regression and stepwise analysis to analyze the relationship between models. Li and Guo (2012) used the second model to develop the maintenance cost planning framework. This model established a maintenance cost prediction model in university buildings by analyzing historical data using simple linear regression, multiple regression, and artificial neural networks. The third is the cost prediction model for office buildings by Au-Yong et al. (2013), which identified six features that must be included in the maintenance plan for cost-effectiveness.

The framework adopted by this study established that the previous maintenance cost models did not factor in how the maintenance strategy applied can affect cost-effectiveness (Le et al., 2018). This is because the decisions made on maintenance are more intuitive than rational. Therefore, maintenance and operational data from the building are required. However, studies have revealed that traditional maintenance does not use data; the facility managers rely on physical and visual inspections to identify problems (Ali, 2009). In addition, studies have also indicated a lack of communication between management and facility managers (Au-Yong et al., 2017; Hua et al., 2005). Zavadskas et al. (2010) stated the need for data collection and management tools to monitor buildings maintenance and operations as well as support decision-making. Tools like CMMS, BIM, and IoT will aid a great deal

in collecting maintenance data (Ismail et al., 2020; Rowland, 2015).

The framework views maintenance cost planning as an activity that receives input to produce output. It also identifies controls needed to produce the correct output and the mechanisms needed to perform the activity. Upon closer examination of the framework, the features of 'input' and 'control' comprise the organizational factors. While the 'mechanism' features comprise technological factors. The framework does not consider the environmental factors that may affect cost-effective decision-making. Furthermore, the framework and the models it was developed from used regression to analyze data. None of the studies applied structural equation modeling (SEM) in their study. Although this framework identifies the technological challenges that prevent a smooth maintenance process, it does not look into the readiness of organizations to incorporate technologies that can capture and manage data for analytics which will aid in cost-effective decision-making.
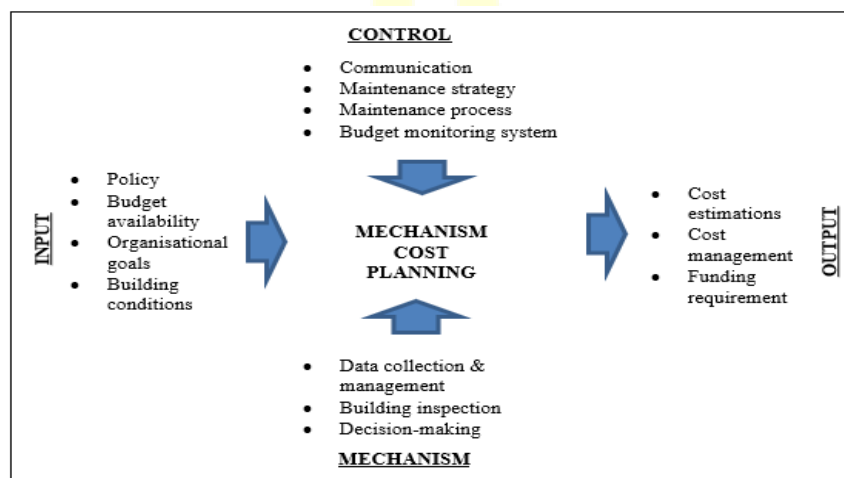

Figure 1 Maintenance cost planning framework by Le et al. (2018)

Framework Development

From the selected theories above, this study identified the factors that affect analytics readiness and how they affect cost-effective decision-making. Figure 2 presents the developed framework.
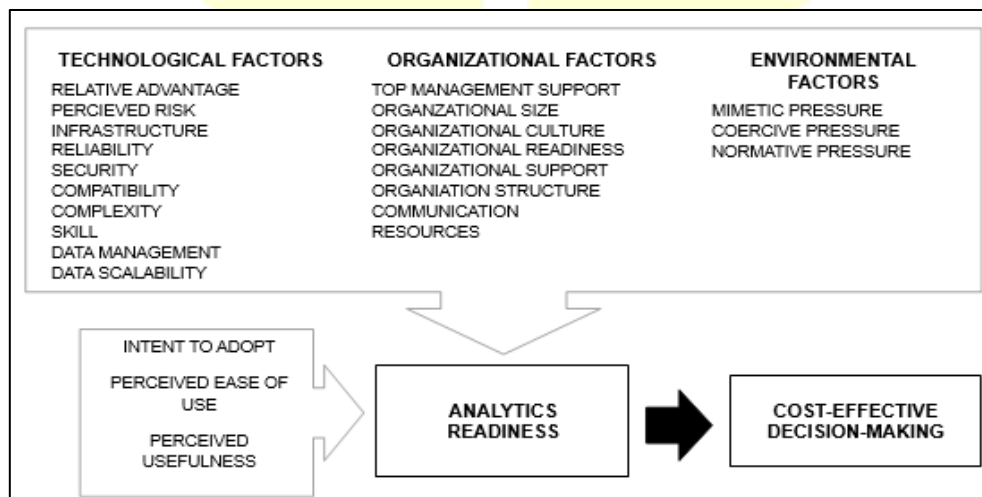

Figure 2 Analytics readiness framework for cost-effective decision-making

CONCLUSION

In building maintenance, the need for cost-effective decision-making cannot be over-emphasized. While studies have attested that the support of data analytics will improve the maintenance decision-making process, there is still a lack of sufficient studies on readiness to carry out analytics. This study identified factors that affect analytics readiness for cost-effective decision-making by examining three frameworks/models, namely, Technology Acceptance Model, Technology-Organisation-Environment (TOE) framework, and Maintenance Cost Planning. It concluded with the development of a framework to serve as a guide to improve maintenance decisions and maximize resources effectively.

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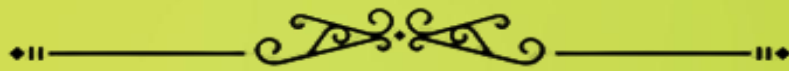
ARCHITECTURE

SUSTAINABLE BUILDING MATERIALS FOR ACHIEVING ECO-FRIENDLY IDP CAMPS: LITERATURE REVIEW

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ABSTRACT

This study aims to identify sustainable building materials for achieving eco-friendly IDP camps. The study achieved the aim using the following objectives; to identify the architectural elements in an IDP camp and to identify sustainable building materials suitable for the construction of IDP camps. Although there is research on sustainable building materials used in building construction, there are very few studies of these materials specifically used in IDP camps. Hence, this research is to provide adequate information in this area. A qualitative research method was used in this study. Open-access publications within the last 10 years were sourced from reputable online databases such as Google Scholar, Scopus, web of Science and ScienceDirect. Relevant data were extracted and analyzed through content analysis. The results of the study underscored sustainable building materials that are suitable for achieving eco-friendly IDP camps. Such materials include; adobe blocks and bricks, recycled glass, plastic and metal, earth bags, bamboo and stone. In conclusion, sustainable building materials suitable for constructing eco-friendly IDP camps have positive impacts on the environment thereby encouraging sustainable city development. The study's expected contribution is to provide knowledge to architects, planners, and other building professionals in considering the use of sustainable building materials in the design of IDP camps to achieve environmental sustainability.

Keywords: Eco-friendly, Environmental Sustainability, IDP Camps, Sustainable Building Materials

INTRODUCTION

According to the United Nations Guiding Principles on Internal Displacement, Internally Displaced Persons (IDPs) are individuals or groups of individuals who have been forced or compelled to flee or to abandon their homes or places of residence, due to or to avoid the effects of armed conflict, generalized violence, human rights violations, natural or man-made disasters and have not surpassed a country's border (UNHCR, 2020). IDPs (internally displaced persons) can also be said to be victims of trauma or conflict who are compelled to flee from their customary

place of residence and seek temporary sanctuary inside the same territory, region, or country borders. They are typically not regarded as migrant refugees or asylum seekers because they

do not require the diplomatic intervention that results from cross-border migration, but they nonetheless face the challenges of being forcibly relocated, integrating into society, and acclimating to a new culture for an unspecified period (Enwerekowe, Obianuju and Ibrahim 2019). The number of IDPs worldwide was estimated to be 46 million in 2020. IDPs face various challenges, including access to basic needs such as shelter, food, and water, as well as protection and security. Although, they are entitled to all the rights and promises just like other citizens and habitual residents of the country. As a result of this, it is the primary responsibility of the national authorities to prevent forced displacement and to protect IDPs.

A team of experts and stakeholders participate in the planning of settlement camps, with architects playing a key role as managers of the built environment and supervisors of space creation. In order to provide sustainable solutions for the presumably complicated nature of temporary housing, which will be serviced by efficient waste management systems, architects must draw on their problem-solving skills and expertise in both design and planning. As long as the physical surroundings in which they live experience significant degradation, the health and well-being of the inhabitants of these displacement camps will continually be under the very real threat of fire breakouts, the spread of infectious diseases, bad weather, and more violence.

In recent years, there has been a growing interest in promoting environmental sustainability in IDP camps through the use of green building materials. Green building materials are those that have a minimal environmental impact, such as being energy-efficient, renewable, and non-toxic. The use of green building materials can improve the environmental sustainability of IDP camps and provide a

healthier and more comfortable living environment for IDPs.

Over the past ten years, millions of individuals have been forcibly uprooted from their homes. In comparison to individuals who go across borders in search of safety as refugees or asylum seekers, the number of Internally Displaced Persons (IDPs) is much larger (United Nations Refugee Agency (UNHCR), 2021). The Internal Displacement Monitoring Center (IDMC), 2020, estimates that there are 82.4 million forcibly displaced persons worldwide, of which 55 million are internally displaced people (IDPs). Of these, 48 million are the consequence of war and violence, while 7 million are relocated because of natural disasters.

Previous studies have highlighted the importance of using green building materials in promoting environmental sustainability in various settings, including IDP camps. For instance, a study by Hadi et al. (2017) identified the potential benefits of using green building materials in refugee camps, including reducing energy consumption, improving indoor air quality, and promoting sustainable development.

However, despite the potential benefits of green building materials, there is a lack of comprehensive research on the use of these materials in IDP camps. Moreover, there is a need to identify the specific types of green building materials that are suitable for IDP camps, given the unique challenges and constraints faced in these settings. Therefore, this study aims to identify green building materials that can be used to achieve environmental sustainability in IDP camps.

The issue of environmental sustainability has become increasingly important in recent years, with the global community recognizing the need to address climate change and reduce greenhouse gas emissions. One area where environmental sustainability is particularly important is in the design and construction of buildings. Buildings are responsible for a significant portion of global energy consumption and greenhouse gas emissions, and there is a growing need for buildings to be designed

and constructed in a way that minimizes their impact on the environment.

In the context of internally displaced persons (IDP) camps, environmental sustainability is especially important, as these camps are often located in areas that are already environmentally vulnerable, and the people living in these camps are often among the most vulnerable in society. The use of traditional building materials and methods in IDP camps can harm the environment and the health of the people living in these camps. Therefore, the problem addressed by this study is the lack of knowledge and understanding about the use of green building materials for achieving environmental sustainability in IDP camps. Despite the growing interest in environmental sustainability and green building, there is a lack of research on the use of green building materials in IDP camps, particularly in the context of developing countries.

This study aims to identify green building materials for achieving environmental sustainability in IDP camps.

The objectives are; to identify green building materials for building construction and to identify green building materials suitable for the construction of the IDP camp.

This study aims to address this gap in the literature by identifying green building materials for achieving environmental sustainability in IDP. By doing so, this study will contribute to the development of sustainable housing solutions for vulnerable populations and provide insights into the use of green building materials in the context of developing countries. The findings of this study may be relevant to government agencies, non-governmental organizations, and other stakeholders involved in the provision of housing and infrastructure in IDP camps. By implementing the recommendations of this study, stakeholders may be able to mitigate environmental degradation and enhance the well-being of IDP communities.

Furthermore, the study contributes to the body of literature on sustainable development in the context of humanitarian crises, specifically on green building materials.

METHODOLOGY

To achieve the objectives of the study, a qualitative research method was employed using content analysis to evaluate data from open-access publications gathered from reputable online databases, including Google Scholar, Scopus, and ScienceDirect, all published between 2011 to 2021. The initial search was conducted using keywords such as "green building materials", "environmental sustainability", "IDP camps", "renewable resources", "green architecture", and "sustainable development".

The inclusion criteria for the studies were: (1) published in the last 10 years (2) focusing on green building materials in residential buildings, (3) reporting on the impact of green building materials on health and wellbeing, and (4) reporting on the cultural and social factors influencing the adoption and use of green building materials in IDP camps The exclusion criteria were: (1) studies that did not meet the inclusion criteria, (2) studies that are not peer-reviewed, and (3) studies that do not specifically focus on green building materials and environmental sustainability.

After screening the titles and abstracts of the identified studies, full texts were obtained for further analysis. Data extraction was carried out using a pre-designed data extraction form that captured relevant information from the studies, including the author(s), year of publication, research questions, study design, participants, data collection methods, data analysis methods, and main findings. The extracted data were then analyzed through content analysis. The identified themes were then organized into categories and sub-categories.

MAIN RESULTS

The relevant literature for this study is

summarized in this chapter. It discusses green building materials for building construction including the reasons for their use. It also highlights the green building materials suitable for the construction of IDP camp including the reasons and how they aid in the achievement of environmental sustainability.

Green Building Materials for Building Construction

According to Chang, Huang, Wu and Chang (2015), Green building materials are ecofriendly, healthful, reusable or quality materials for example; fallen leaves, chips of wood, iron powder, waste newspaper, waste concrete, reservoir silt, etc. which are capable of reducing its influence on the environment and health of people all through its life cycle including during the manufacturing, usage, disposal and recycling processes. Wei, Ramalho and Mandin (2015) stated that they are made from harmless and natural elements and can minimize Indoor Air Quality (IAQ) pollutants. GBMs can meet the needs of building occupants, building regulatory requirements and also help divert IAQ liability claims. Hunag, Wagang and Wang (2015) mentioned that recycled green building materials, such as fly ash, rubber powder and glass sand encourage environmental sustainability in the construction industry.

Reasons for the Use of Green Building Materials for Building Construction

Many of green building materials have numerous benefits which can be divided into three parts: economic, social and environmental benefits. It was clearly stated in What Is Green Design? 10 Benefits of Green Building | NewSchool (2022) that green building materials, such as reclaimed decking and roofing, not only withstand the elements for many years but also require much less management. Additionally, they save occupants or households money on utility bills, reduce the life cycle cost and increase property value for building developers (World Green Building Council, 2016). Wienerberger (2023) stated also that they reduce expenses spent on operations by

increasing productivity and reducing energy and water consumption. Poon, Zhan and Shi (2013) depicted that using green building materials for sustainable building designs reduces the consumption of resources and maximizes the efficiency of resources utilized.

Green building materials are beneficial to building occupants because they lack damaging chemical treatments. Residents of a green structure have seen a significant improvement in their health, stress levels, and overall quality of life because of improved interior design features including lighting, thermal conditions and ergonomic features. The performance of building users improves when gas emissions are reduced and indoor air quality is improved.

Green designs developed with the use of green building materials are also beneficial environmentally. By using water-saving plumbing equipment, such buildings not only minimize water waste but also ease the burden on shared water supplies. It permits water recycling and the use of alternative water sources by installing specially designed equipment to purify the water (such as rainwater). These advancements safeguard future access to clean water supplies in addition to saving this essential natural resource. Green buildings can benefit the environment by generating their own energy or consuming less energy and by reducing air and land pollution. In comparison to other industries, the construction industry has the greatest potential for drastically reducing global greenhouse gas emissions. Also, stormwater runoff and the heating effect are reduced.

Green Building Materials suitable for the construction of IDP Camp

Earthbag is an eco-friendly material that can be used for walls as wall bricks and floors of any building in an IDP Camp. According to Adeniyi, Mohamed and Rasak (2020), by compressing earth into forms, rammed earth is produced which is also used for construction. Recycled materials such as recycled paper, glass, plastic, and crates of beer bottles loaded with sandbags and metal can be used for

constructing walls, windows, foundations and doors of emergency shelters and other necessary facilities in an IDP Camp. According to Urban Agenda Platform (2017), The Green Refugee Camp model introduced transitional shelters made from locally produced bricks that are not seared with wood or any other type of fuel have important sustainability benefits. Traditionally, UNHCR makes efforts to construct environmentally friendly emergency shelters made of wooden poles and plastic sheets with a shelf life of up to six months. Bamboo is a fast-growing renewable resource that can be applied in emergency shelter construction including floors, roofs and walls. Agricultural waste products such as peanut shells and wheat husks are used to produce eco-friendly stoves and briquettes which are better than traditional wood fuel for cooking. Stone is a durable material that can be applied to walls and foundations of offices, staff quarters and other facilities within an IDP camp.

Reasons why they are suitable for the construction of IDP Camp

Earth bag and recycled materials are readily available and have a low carbon footprint which have a positive impact on the health of the IDPs. The materials for producing bricks can be sourced from within the camp or surrounding area, eliminating the carbon footprint caused by production and transportation completely. Bamboo is readily available, cost-effective and easy to use for construction. Due to this, thousands of people can be accommodated in emergency cases. An eco-friendly stove as a cooking alternative

CONCLUSION

The purpose of this study is to elucidate green building materials for achieving environmental sustainability in IDP camps. According to the findings, green building materials used for building construction provide economic, social and environmental benefits which are reducing energy and water consumption, improving indoor air quality and productivity, reducing land pollution and protecting natural resources respectively. Also, earth bags,

is more environmentally friendly than using firewood and can be produced in a refugee camp. This eliminates the need for refugees to go outside the camp to search for wood which is oftentimes dangerous. Stone has a low carbon footprint and is a long-lasting material.

Impacts of Green Building Materials in Achieving Environmental Sustainability

Adeniyi et al., (2020) highlighted that Earth's low carbon footprint reduces harmful gases released into the atmosphere. Also, recycled materials reduce waste, and land pollution and conserve natural resources. The natural material used in adobe significantly lowers the net energy consumption and waste production of the structure. Adobe bricks produce minimal total waste and zero hazardous waste. Their footprint on the environment is small. Morabito (2022) stated that when materials are harvested from the local environment, transportation energy decreases significantly. Anon (2015) explained that Bamboo reduces pollution, up to 35% of carbon dioxide is reduced in the climate and delivers more oxygen. Bamboo helps lower the light intensity and protects against ultraviolet rays. It helps decrease water pollution. Bamboo can be harvested and replenished without destroying the natural forest. The eco-friendly stove cooking alternative helps to protect the natural resources and prevents conflicts between the host communities and the internally displaced persons. Stone reduces environmental pollution thereby encouraging environmental sustainability.

recycled materials, bricks, bamboo and stone are suitable for constructing IDP camps because of their positive impacts on the environment thereby encouraging sustainable city development. The study's expected contribution is to provide knowledge to architects, planners, and other building professionals in considering the use of green building materials in the design of IDP camps to achieve environmental sustainability.

ACKNOWLEDGEMENT

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WALKABILITY IN UTM JOHOR BAHRU CAMPUS AS SUSTAINABLE UNIVERSITY

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ABSTRACT

This paper explores the potential for transforming the environment of the Universiti Teknologi Malaysia (UTM) in Johor Bahru into a sustainable environment. The study draws on previous research conducted at the UTM campus, as well as similar studies looking at sustainable walking in the university environment to develop strategies to promote sustainable mobility. The research paper proposes a methodology based on previous studies and the researcher's experience of walking on campus.

To assess the feasibility of creating a sustainable environment for pedestrians, the study employs field experiments, image analysis and pedestrian observation. The results highlight specific areas where changes can significantly increase students' preference to walk on campus instead of relying on cars for short distances.

The researcher found that implementing the recommendations described in this article can positively change the walking experience, which has been supported by similar studies. These results underline the potential impact of the proposed measures. Implementing the suggested actions can change students' perceptions of walking on campus, leading to greater enthusiasm for this sustainable mode of transport.

In conclusion, this research paper explores the prospects for creating a sustainable atmosphere around UTM Johor Bahru. By referring findings from previous studies on the UTM and on sustainable walking in university, as well as the researcher's first-hand experience through fieldwork and observations, the study identifies specific points for improvement. It shows that implementing the recommended changes can improve the experience of walking for students, encouraging a shift away from car use for shorter distances. The results of this study provide valuable insights for the development of a sustainable pedestrian environment in the UTM and similar settings.

Keywords : Walkability 1, Sustainable 2, Campus planning 3

INTRODUCTION

This study investigates the feasibility of creating a sustainable environment at the Universiti Teknologi Malaysia (UTM) campus in Johor Bahru. Based on previous research conducted at UTM and related studies on sustainable mobility in the university environment, the study aims to formulate effective strategies to promote sustainable pedestrian practices. The proposed methodology is based on the synthesis of existing research findings and the researcher's experience with pedestrian traffic on campus.

The paper is the result of a research conducted on promoting pedestrian activities in a specific research area at UTM, Johor Bahru, Malaysia. The study uses a comprehensive approach that incorporates student surveys, relevant previous research, experiential data, and photographs of the site. The research paper includes insights from UTM students that capture their perceptions of the current sidewalks and potential areas for improvement. It also uses information from previous studies and research at institutions that share similarities with UTM in terms of climate and ecological context. These various data sources provide a contextual foundation that facilitates the development of policies to transform the central campus area into an environmentally conscious space that promotes pedestrian mobility and discourages students from using cars.

Integral to the research are visual and geographic analyzes. The researcher's first-hand experience is supported by an analysis of photographs taken in the field that provide insight into the current condition of pedestrian facilities. In addition, a detailed examination of university maps provides a comprehensive understanding of campus layout and its impact on pedestrian accessibility and navigation. Complementing the visual and geographic analyzes, specific deficiencies in the current pedestrian infrastructure are identified, paving the way for targeted measures to improve the pedestrian experience within the university.

This research is a thorough investigation that brings together a range of data sources and methods to explore the development of a sustainable pedestrian environment at UTM. By bringing together experiential, theoretical, and empirical findings, the study provides practical recommendations for transforming the campus center into a pedestrian-friendly space, thereby encouraging students to use walking as their primary mode of transportation and reduce car dependency.

THE DEFINITION

In this research, certain definitions are necessary because they serve as the basis of the research study. The term "walkability" has historical origins that date back to at least since the 18th century, as according to the Oxford English Dictionary (2013). In the context of this study, the term "walkability" is frequently used to describe the extent to which a particular place or area is suitable for walking. Although scholars have differing views on the exact literal definition of this term, it can generally be understood as a measure of how effectively places facilitate walking with optimal comfort, happiness, environmental sustainability, and generally adherence to sustainable practices during pedestrian activity (Forsyth Urban Design International, 2015).

Meanwhile, the concept of a "sustainable campus" refers to a place where the community is provided with opportunities to learn and gradually promote a culture of sustainability, and responsible stewardship of natural resources (Dawson team, 2016). Additionally, sustainable development" is referred to by the United Nations as a form of development that meets current needs while ensuring that it does not compromise the ability of future

generations to meet their own needs (Kuhlman, 2010).

WALKABILITY IN UTM

In 2009, UTM began its sustainability effort, focusing on paper recycling and energy conservation. It was the first institution to be awarded the prestigious Star EMGS 1 sustainability rating. In addition, UTM demonstrated its commitment to sustainability through successful reforestation initiatives such as the "My Tree Evolution" program. This program aimed to promote dialog among institution activists and discourage excessive car use through events such as "car-free day" (UTM Sustainability, 2019; Ismail, 2020). Despite its commendable achievements in various sustainability aspects, UTM faces challenges in promoting sustainable walking practices and addressing student needs by encouraging walking, instead of other mean of transportation use such as cars, busses, and motocycles. Figure 1 shows the campus map of UTM Johor Bahru campusand highlights the main location. The research is located in the central part of the university, which includes the mosque and the center of UTM.

The primary sustainability issues on the UTM campus revolve around the design of pedestrian routes and accessibility to places or buildings in the university. The inadequate design of pedestrian walkways hinders their usability and effectiveness, while the presence of damaged roads and the lack of adequate sidewalks pose maintenance issues. Together, these factors impede the university's progress in promoting sustainable pedestrian practices and moving away from other automobile transportation dependency. To overcome these challenges and achieve its sustainability goals, UTM should prioritise improving pedestrian infrastructure and access. Establishing well -designed sidewalks, prioritizing maintenance and creating designated walkways can promote a pedestrian-friendly environment. Integrating sustainability into campus planning is important. This can be achieve by adopting sustainable transportation policies, such as promoting bicycles or electric vehicles in providing convenient and secure bicycle parking.

In addition to improving infrastructure, awareness campaigns can highlight the environmental, health and social benefits of walking. Active participation by students, faculties, and staffs can foster a culture of sustainable mobility and instill a sense of environmental responsibility. By prioritizing pedestrian infrastructure, and raising awareness, UTM can create a pedestrian-friendly environment on campus and encourage a shift to a better choice.
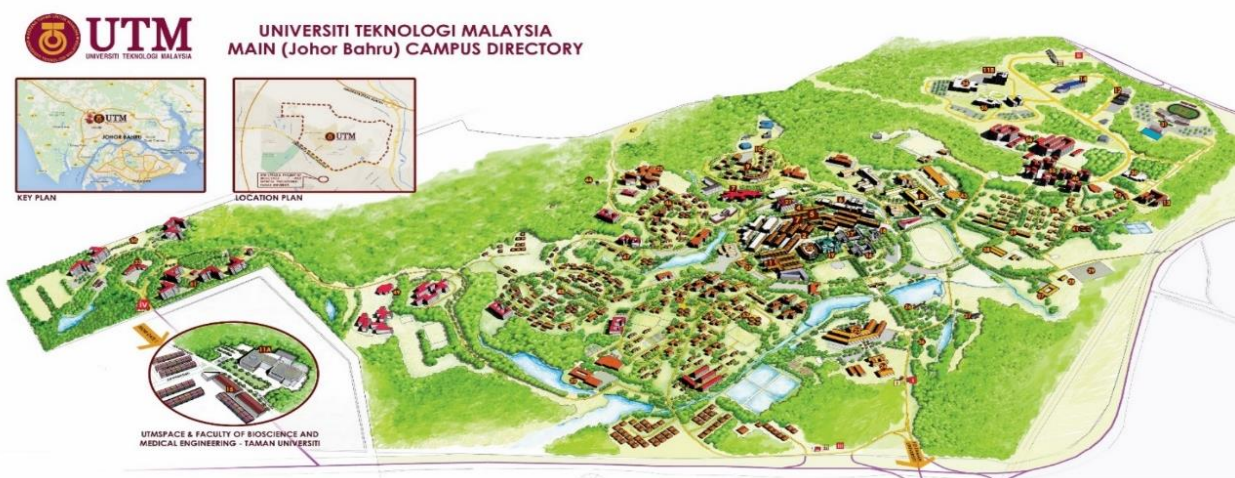

Figure 1 The mapping of UTM Johor. (Source: UTM International ,2021).

MATERIALS AND METHODS

In this research, several methods are used to investigate the issue of walkability and sustainability at UTM. The methods include the researcher's self-observation, analysis of data from UTM students through the semi-structured interview as part of the primary research conducted, comparison of data with other institution comparable to UTM, and examination of relevant information that contribute to the research topic.

The main research process is structured in the following order: Formulation of the research topic, initial observation and photographic documentation. Then, the research will culminate in the use of journals, newspapers articles, interviews with UTM students, data analysis and presentation of findings.

The research paper itself will be divided into several sections. The Introduction will provide an overview of the objectives and scope of study. The Definitions section will clearly and consicely explain important terms relevant to the study, such as "walkability" and sustainability". It will then highlight the history of the university, relevant contextual and background information.

The section on first-hand experiments present the result of the researcher's direct observations on the UTM campus and provides first-hand insights into the prevailing conditions for walkability and sustainability. The results of the interview conducted with UTM students, which provide valuable data to support the analysis. In the analysis section, the data collected will be thoroughly examined using appropriate methods and techniques to draw the conclusions. The results of this analysis are presented in a coherent manner, contributing to the overall research objectives.

In addition, this paper will focus on four key aspect, which are 1) safety, 2) comfort, 3) accessibility, and 4) the desirability of walking. These key aspects draws from from Layla's (xxxx) research, which shares thematic similarities with this study and the main research are about. In overall, this research uses a combination of methods including self-observation, data analysis of photographic documentation, data comparisons with relevant study conducted for other local institutions, extensive literature review to comprehensively examine the issue of walkability and sustainability at UTM. By adhering to a well-organised structure, the work is expected to provide valuable insights and contribute to the ongoing discourse on campus walkability and sustainable practices.

THE CASE STUDY

One of the case studies reffered for this research that focuses on the walkability in a campus was conducted by Keat (2016). Using University of Malaya, the study revealed issues that are similar to those encountered with walkability issues at UTM. Keat (2016) pointed out the inadequate presence of sidewalks for walking in certain áreas. In some locations, sidewalkds were not provided, requiring students or users to walk on grassy terrain and uphill (Keat (2016). Apart from that, some sidewalks were not wide enough for two people to walk in opposite directions. This concern was also expressed by Fard (2012) on the the issues in UTM, where the students and the users faced similar challenges walking in the central área. This can be seen in Figure 2 and Figure 3 taken by the author during his fieldwork.

Another concern was the lack of shaded areas that protect from the sun and rain along most of the sidewalks, which made the streets unsuitable for walking. Students expressed a desire for covered walkways to protect themselves from rain and sun, as the lack of such facilities discourage walking. Moreover,

the sidewalks in the área of UTM were perceived as uninspiring and improper with only Grass and no points of interest or places to rest.

Figures 2 and Figure 3 illustrate that UTM has similar issues to the University of Malaya, such as the lack of clear pedestrian pathways, narrow sidewalks

Figure 2: The picture above shows the pedestrian walkway provided ended at the drainage too. Not well connected and unsafe for pedestrian. (Source: Author, 2021).

*Figure **3**: Two pictures showing the dimension of the buildings, the length of the pedestrian paths, and the intersection of corridors with car streets. (Source: Author, 2021).*

that impede passage in both directions, inadequate covered walkways for users to get covered from direct sunlight and heavy rain, and overlap between pedestrian and vehicular zones. However, during the researcher's direct observation during a site visit, the researcher noted additional challenges specific to UTM. This includes the vast expanse of the campus, inadequate connectivity between buildings

and the lack of wayfindings, especially for pedestrian.

Hence, the case study on the walkability in campus revealed issues similar to those faced by UTM. Issues with sidewalks, narrow walkways, lack of shaded áreas and inadequate separation of pedestrian and cars were not uncommon. However, direct observation

at UTM revealed other issues at hand, such as the sprawling places within campus, lack of building connections and por pedestrian wayfindings. Addressing these issues is critical to improve overall user experience of walkability and promoting sustainable mobility at UTM.

Figure 4 (left) and Figure 5 (right): The four types of pedestrian walkways or sideways at UTM that are designated for pedestrians; (Source Author, 2023).

THE WALKING FIRST HAND-EXPERIENCE

The university was deliberately chosen as a research area to the possibility to talk to students because it is the same university and to provide research similar to the case of UTM University, but it does not fit identically, and due to the availability of research.

The UTM Johor Bahru covers a huge area and is characterized bu numerous open spaces between faculties, which makes it difficult for pedestrian to get from one place to another. There are also certain areas where there are no pedestrian walkways, making it difficult to walk across small plateaus or damaged roads.

The experience of walking was documented through photographs of prominent and conspious location along the pathways to visually emphasised the subject of this study.

According to researcher's findings, walking in areas where they are narrow, dilapidated and impassable, especially near the riverbanks or bridge, proves to be difficult, challenging and time-consuming. While the weather condition were favourable during the researcher's visit, it is worth noting that hiking or walking would have been challenging in the event of rain, as there are no covered trails. The

researcher also appreciated the wildlife encountered along at some parts of the pathways, including squirrels, large reptiles, and several species of birds.

main road that lead to Sultan Islamic mosque, Sultanah Zanariah Library

area that can be use as walk-way

student recruitment and admission division

Figure 6 The most important points of the area being studied. (Source: Author, 2021).
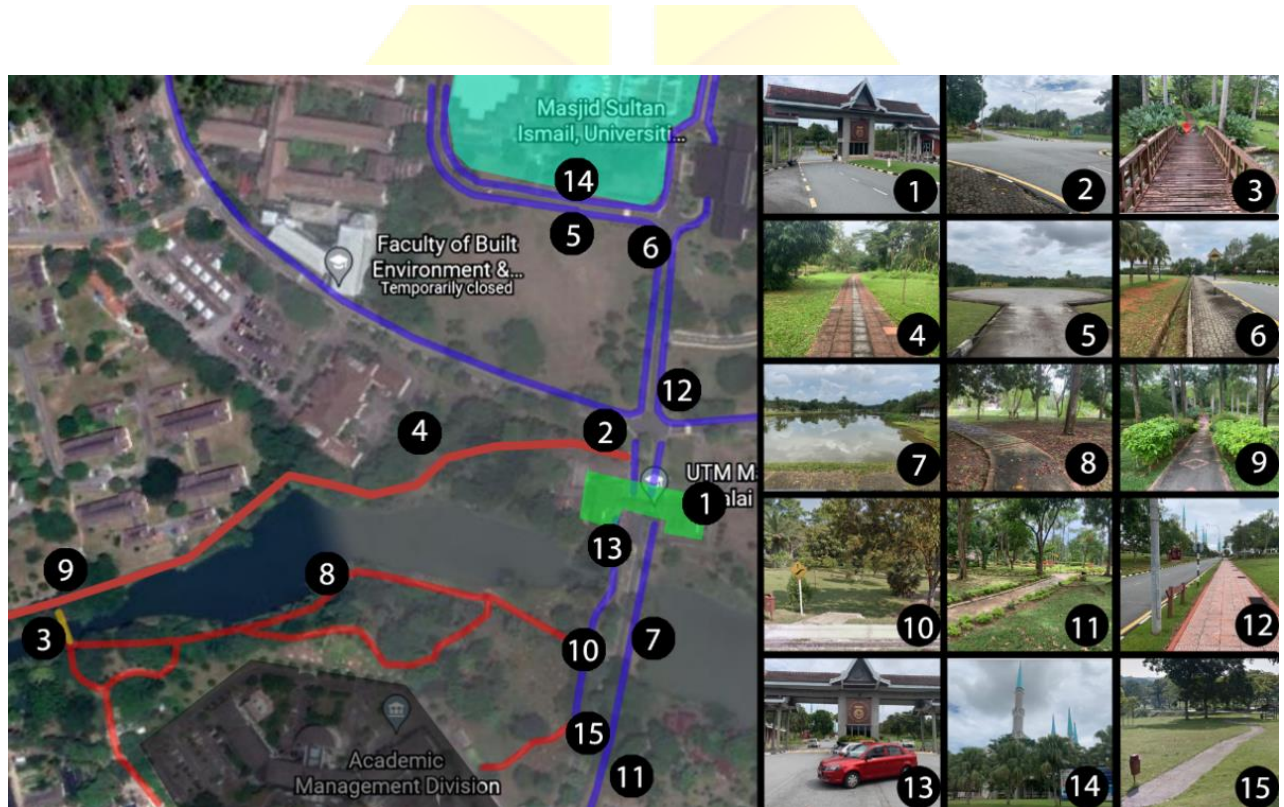
Figure 7 The most important points of the area being studied;Source: Author, 2021).

THE WALKWAYS CONDITION AT THE RESEARCH AREA

Referring to the research area highlighted, there are four different types of walkways that are only accessible by walking. Firstly, attention is needed to address damaged routes, necessitating repair and restoration.

Second, narrow passageways need to be widened to allow for access in both directions and increase pedestrian comfort while walking. It is observed that people sometimes tend to be walked across parking lots or green areas as a short cuts to reach their destinations. The sidewalks shown in the images need to be restored and maintained, with several paths requiring attention. Third, the need for safety measures on the streets, as walking next to vehicular traffic or uncovered water drains is a potential hazard.

The picture shows how crowded the pavement is for pedestrians. It needs to be enlarged to create a better atmosphere and improve pedestrian comfort along the corridor. In the absence of designated sidewalks, pedestrian is forced to walk through parking lots or green spaces to reach their destinations.

OBSERVATIONS

In order to identify any open spaces or intersections where people should be walking more quickly than in other areas, the researcher conducted three days of surveillance at the university (Figure 8) while the students were present, from 8.00 am to 6.00 pm. Photographs were captured during this period, including areas beyond the four designated zones, to aid in the investigation

A selection of photos taken during the three-day surveillance at 8.00am, 1.00pm and 5.00pm is presented, (Figure 9) while to a more comprehensive collection can be found in the complete research records. Next, Initial observation focused on how people move around campus to identify potential issues. The first-hand experience were conducted in which participants walked the campus, took photos, and recorded areas that needed improvement. The researcher then reviewed relevant literature from megazines, newspapers and reputable websites to gather additional data. Subsequently, the opinions of UTM students were obtained through interviews, and the collected data were organized and analysed to develop recommendations. The researcher's methodology is divided into four main categories as quoted from Layla's research on a similar topic, which include safety, comfort, accessibility, and desirability of walking. - street observation. (Layla M, 2020).

For clarity, the four categories are summarised as follow (Figure 10)::

1. Safety: evaluating the different types of walkways on campus in terms of traffic safety, wildlife encounters, lighting and comfort.

2. Comfort: Evaluation of the walking experience in terms of pleasant views of buildings and campus cleanliness.

3. Accessibility: Analysing the frequency of inconveniences and determining if there are sufficient routes for students to reach their destinations, considering the condition and need for sidewalk expansion.

4. Attractiveness of walking: Examining the overall enjoyment and experience of walking (Figure 6).

These key points from the original study help to understand the research methodology, the researcher's perspective, and the structure of the study and its findings.

Figure 8: Street observation method (Source Layla M, 2020)

Figure 8 : (photos that were taken from the search site three different times: author).
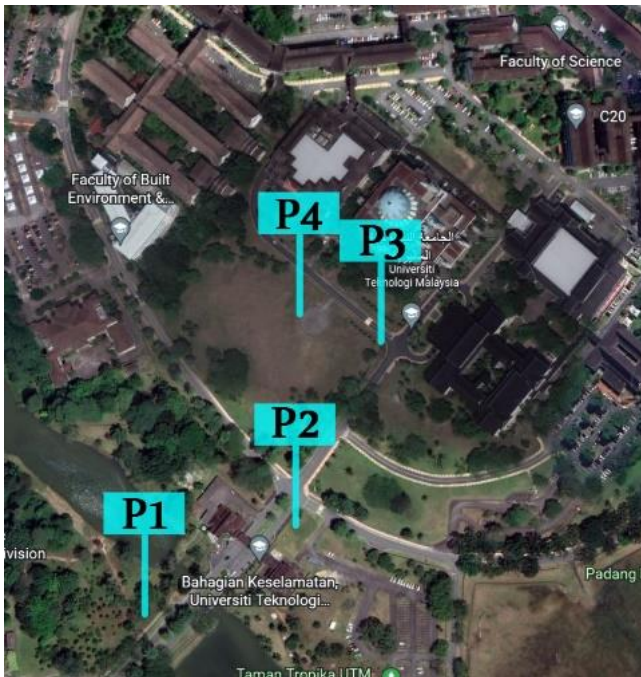
Figure 9: The places that were chosen by the researcher as main points; (Source Author, 2023

Figure 10: Street observation method (Source Layla M, 2020

CONCLUSION

In overall, the researcher aimed to encompass all comparable cases to UTM that can contribute to the understanding of walkability and sustainability. Following

the first-hand experience and comparative analysis with Layla's work, for key aspects were identified for comparison.

1-Pedestrian facilities & Safety:

The sidewalk condition as seen in the photographs, the traffic lanes and the numerous uneven and damaged roadways must all be improved or rebuilt more efficiently. While some locations on the university campus have well-designed pavement facilities, not all roads benefit from them, leading to incomplete pathways and the need for additional road planning.

Sidewalk widening can be implemented more effectively, given the absence of space constraints at UTM, resulting in more comfortable pedestrian paths. The sporadic presence of obstacles on the sidewalks is the only issue, as they do not cover all areas.

▫

Lighting is not problematic due to the absence of particularly narrow lanes or roads. Crosswalk lines should be made more obvious and made available as needed. Overall, the observed region conveys a sense of safety.

2- Comfortable walking environment:

Buildings with interesting facades are present near the UTM mosque; however, they are far from the university's main entrance and the central area of the region. Enhancing the aesthetic appeal could involve rebuilding both sides of the roads. Meanwhile, vegetation and greenery are abundant, there are imited shaded areas and rest stops along the lengthy roadways due to the lack of facilities. Cleanliness and maintenance need closer monitoring, especially in areas with damaged and unsafe roads for walking. Comfort and enjoyment are compromised due to the distance, lack of reast areas, and absence of appealing buildings or facades along the road.

3- Walking Connectivity/ Accessibility:

The status of pavements near the drainage is insufficient to prevent potential tripping hazards, necessitating improvements to avoid potential injuries. Continuity of sidewalks may be interrupted at locations where streets overlap, requiring attention for seamless pedestrian pathways. While directional signage is good in front of destinations, placing more signs along lengthy highways would enhance navigational convenience. Improving the visibility of the pavement's accessibility is necessary, as clear walking paths were not apparent, resulting in the need to ascend and descend to access the walking route.

4- Walking Attractiveness:

The richness of the physical surroundings and visual diversity are lacking along most of the university's sidewalks, particularly in the central sections of long roads. Landmarks are present in front of buildings but not alongside roads, indicating the need for better placement to aid wayfinding. Designated lanes for cyclists are absent, leading to shared usage of roads with cars and highlighting the necessity of dedicated lanes. Enhancing the presence of enticing street furniture in front of buildings would provide pedestrians with more resting opportunities. Walking proves challenging without break stops or shaded areas along the route, as the lengthy highways hinder halting in the middle.

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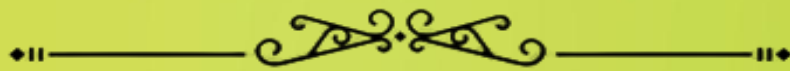
QUANTITY SURVEYING

CONSTRUCTION PROJECT COST ESTIMATION SOFTWARE UTILIZATION IN CONSTRUCTION INDUSTRY

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ABSTRACT

Software is widely used in all industries all over the world and it made the job easier. It also helps to increase the output of work and significantly boost the efficiency of work in the industry. In the modern days, most of the companies in the construction industry use software for cost estimation, measurement and other related works. The main idea for an organization to apply software cost estimates is to define why, when and how the cost estimates are measured or calculated. There are three problems have been identified as the problem statement for this research which is the lack of skills in the usage of software, the complex structure and usage of software and the lack of a historical database of cost measurement. This research aims to identify the barrier in the application of cost estimation software for QS firm. The data collected through distributed questionnaire survey to selected QS firm. As for the result, majority of the respondent agree with high training cost as one of the barriers. High installation cost, lack of experience among staff and complicated cost estimating software to use are among the barriers. Most of this software's users use less than 10 percent of what it can do. This indicates that the usage of software is complicated and a proper training is needed in order to fully utilized the software. Lastly, majority of the respondent agree with data will lost if do not keep properly and are many possible causes that can cause data loss which is virus or malware, mechanical damages, power failure and other software related problems. Although software is a good alternative to do cost estimating, it also carries the risks for data loss due to unforeseen circumstances.

Keywords : Project Cost Estimation Software, Local QS Firm, Construction Industry,

INTRODUCTION

The term software is used to describe software used by end users that is real people such as email applications, word processing, or spreadsheet applications. The advantages of using any of these types of applications are that they aim to improve the life of the end user. Email enables us to send messages over long distances almost immediately, word processors enable us to write good looking documents much faster and easier than we could with a typewriter or by hand, and spreadsheets allow us to build spreadsheets that recalculate themselves easily and automatically. Used in this way, software makes available to the end user the power of the computer to accomplish his or her task by saving time, money and effort for the user. Malaysia introduced the Fourth Industrial Revolution in 2018 and since its introduction, many industry and economic sectors in Malaysia started to implement IT and automation in their industry. Construction industry also plays a role in this revolution by utilising the cost estimating software which has low rate of implementation in the industry. In Sarawak construction industry, there rate of the implementation of cost estimating software is still low. Thus, the purpose of this research is to study the utilization of cost estimating software in Sarawak after the introduction of Fourth Industrial Revolution in 2018.

This research arises from the need to study the utilization of cost estimating software in Sarawak Quantity Surveying firm. There are three problem statement for my research which is the training and learning many procedures, cost of software installation and cost of hardware installation. First, training and learning many procedures (Tan Ching Keng, Yeoh Kah Ching, 2012). This is one of the barrier that need to be overcome in order to make full use of the software. Most of the QS firm does not have the leisure and resources to train their estimators in using software and there are many procedures need to be remember when using the software. Second, the cost of software installation

(Aftab Hameed Memon, et al., 2014). The price of a software is expensive and this makes the company hesitate in implementing the usage of software in their firm. The process to install software is a complicated process as it required skills and the price for the skills and the software itself is expensive. Third, the cost of hardware installation (Mehmet F. Hergunsel, 2011). The hardware needs to be upgrade or up to date in order to run a software. This may involve a high cost of expenses due to the number of hardware that need to be upgrade. In order to run a software, a mid to high-end hardware are needed to run the software smoothly and without any technical difficulties. The cost for this hardware is quite high in modern days due to computer being a necessities during these days.

There are varieties of software in the industry nowadays and the most common software used in cost estimating and taking off are BuildSoft, Binalink, Masterbill, Glodon, CatoPro, CostX, Ripac, QSPro, WinQS, etc. All of the stated software helps the quantity surveyors take off, cost estimate, quantity bill preparation, electronic takeoff as well as hard copy takeoff by using digitizers. This also allows quantity surveyors to develop their estimation skills in many ways to fasten the taking off process and this also help to save time and money in the process to prepare the bill of quantities and the estimation process (Tan Chin Keng, & Yeoh Kah Ching, 2012)

Buildsoft, Masterbill, Glodon, CostX, Ripac, QSpro and WinQS are among the software use in the industry. For decades, estimators have been using traditional method in calculating the cost for a project. Using the traditional method, the estimators will have to pass through each drawing sheet divided into architectural, civil, structural, electrical, mechanical, landscape and plumbing drawings and determine the quantity of materials for each item while ensuring that the items are not omitted or doubled (Darren Olsen, & J. Mark Taylor, 2017). This is a very lengthy

process and poses a high risk of error which may lead to inaccuracy of estimate and variation of works. While software is a much faster and accurate alternative, most of the companies still preferred the traditional method. This is because traditional methods have been used for so long and the companies feel that investing time and money in a new method is risky (Darren Olsen, & J. Mark Taylor, 2017). As cost estimators heavily relied on the usage of spreadsheets in taking off and the formula within the spreadsheet become more complex, spreadsheet percentage of error will increase (Jonathan P. Caulkins et al, 2008). This prove that traditional method is not reliable and the used of software is implemented to reduce the risk of error. Commercial cost estimation software application was created to overcome the error created by traditional method by using a hard-coded formulas and data structures. Other advantages of using the software include vast cost and reference databases, predictable and professional-looking reports, speed of estimation preparation, the accuracy of estimates and overall process standardization (Softwareadvise Website, 2019). Through the advancement of technology, estimators now had many alternatives to help with the taking-off and cost estimating process with the help of software invention. Thus, software implementation among construction firm and other companies in construction industries is important for the ease of work

METHODOLOGY

The questionaires use by most researchers for the quantitative analysis. The questionnaires has been distribute to all the quantity surveyors. The questionnaires were tabulate in Google form and were distributed using email, Facebook and whats app médium.

MAIN RESULTS
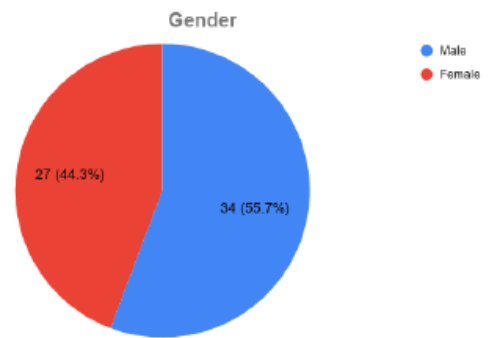
Figure 1 Gender of the respondents

The data analysed shows that 55.7% are male respondents and 44.3% are female respondents which is 34 and 27 respectively. This data is shown in Figure 1.
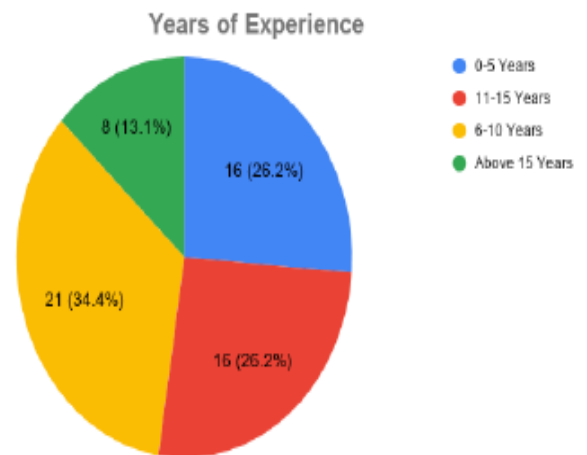
Figure 2 Years of experience in construction

Figure 2 shows the years of experience of the respondents. For this question, there are 4 categories of answer which is 0-5 years, 6-10 years, 11-15 years and above 15 years of experience. The data shows that most respondent has 6-10 years of work experience with a percentage of 34.4% followed by 11-15 years and 0-5 years of work experience at 26.2% and above 15 years of experience at 13.1%.

The first question were asked to the respondent whether their company plan to implement cost estimating software in the near future and most of the respondent's companies already implement cost estimating software while other respondent companies plan to implement software usage in the near future. According to CIDB Report (2016), most of the companies in Malaysia plan to

implement cost estimating software. The most common barrier are:

Table 1 Barriers to implement cost estimating software

Barriers	Percentage
High training cost,	35%
High installation cost,	20%
Lack of experience among staff,	15%
Too complicated to use,	13%
Not flexible in editing measurement works,	10%
Data will lost if do not keep properly.	7%

From the *Table 1*, majority of the respondent agree with high training cost as one of the barriers. Tan Chin Keng, & Yeoh Kah Ching (2012), conduct a questionnaire and high training cost is one of the barriers in implementing cost estimating software in the construction industry. The respondents also agree with high installation cost and lack of experience among staff. This is because the cost to install a software is high and 94 the time and cost to train an employee also high and this is the reason for low adoption of software usage in the construction industry (Mark Taylor, 2017). Next, most respondent agree with the cost estimating software is too complicated to use. Most of this software's users use less than 10 percent of what it can do (Guild R. ,2020). This indicates that the usage of software is complicated and a proper training is needed in order to fully utilized the software. Most respondent disagree that software is not flexible in editing measurement works. According to Informative Architecture (2011), flexibility of software is one of the properties which indicates whether the software is easy to change. This indicates that software is flexible and the same can be applied to cost estimating software flexibility in doing measurement works. Lastly, majority of the respondent agree with data will lost if do not keep properly. According to Jake Frankefiled and Jefreda R. Brown (2022), there are many possible causes that can cause data loss which is virus or malware,

mechanical damages, power failure and other software related problems. Although software is a good alternative to do cost estimating, it also carries the risks for data loss due to unforeseen circumstances.

The survey on how to promote the usage of software in construction industry sector software, Provision of trial software. provided for software training should not Subsidize the price of the software, Offer a free software training course, Give tax exemption or reduction to the company From the analysed data, 80% respondent choose subsidize the price of software as one of the ways to promote software adoption in construction industry find out that to adopt software usage, Government should provide initiative and incentive for the software, the incentive should not be bias to specific type of software only. Many also agree that providing a free training course and provision of trial software can also help to promote software implementation. Aftab Hameed Memon, et al. (2014), stated that subsidizing the software, providing a training and provision of trial software are the incentive to promote software implementation. This can decrease the cost of software and make software more affordable for smaller companies. By providing a free training, more employee will have the knowledge to use cost estimating software and this can contribute to the productivity of the company. Provision of trial software can also encourage the implementation of cost estimating software as they can test the benefits of the software before implementing it. Next, give tax exemption or reduction to the company that adopt software usage and incentive provided for software training should not be bias to specific type of software receive a mixed response from the respondents. Woon Siong Sheng (2015), recommend the initiative by giving reduction or tax exemption for companies that adopt the usage of software to encourage the companies especially small and medium-sized companies to implement the usage of software and also incentive provided for software training should not be bias to specific type of software. By adopting

these initiative, this can encourage the companies in construction industry to implement cost estimating software in their companies.

CONCLUSION

The usage of cost estimating software can be the motivating factors to improve the productivity in doing the quantity surveyors task. The barriers in using the cost estimating software are high training cost, High installation cost, lack of experience among staff, too complicated to use, not flexible in editing measurement works, data will lost if do not keep properly. To promote the usage of software among QS are subsidize the price of software as one of the ways to promote software adoption in construction industry. Many also agree that providing a free training course and provision of trial software can also help to promote 95 software implementation.

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THE CONTRACT ADMINISTRATION OF SOLAR ENERGY IN MALAYSIA

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ABSTRACT

Solar energy, a sustainable and renewable resource originating from the sun, serves as a valuable source of power and heat for residential, commercial, and utility purposes. Contract administration involves the management of agreements between customers and contractors, with a contract administrator overseeing the entire process. In the context of solar power projects, contract administration is commonly referred to as the "solar energy agreement." These agreements govern the relationship between landowners and the parties responsible for constructing and operating the solar projects, often termed as "solar leases" or "Power Purchase Agreements". This study focuses on large-scale solar PV projects, known as solar farms, in Malaysia. These farms utilize solar photovoltaic systems to generate power ranging from hundreds of kilowatts to thousands of megawatts. Solar energy agreements are complex legal transactions with significant economic implications, necessitating a thorough evaluation of their structure and content. The primary objectives of this research are to examine current contract administration practices for solar energy projects in Malaysia and identify contractual issues associated with the implementation of solar energy in the country. The paper reviews existing literature on contract administration practices and contractual issues specific to solar energy projects in Malaysia. However, due to limited knowledge, further research is required to delve into the contractual challenges in the solar energy industry. The insights of solar energy professionals are vital in validating and enhancing this investigation.

Keywords : solar energy, contract administration, contractual issues, Power Purchase Agreement, Solar Leasing

INTRODUCTION

Malaysia, located in the northern hemisphere near the equator, is known for its natural resources, including shoreline, dense forests, and rolling hills. With abundant sunshine, solar energy has significant potential as an alternative resource in the country (Kardooni et al., 2016). The energy sector spends RM15.1

billion annually to produce 120,059 GWh of electricity for 8.45 million people in Peninsular Malaysia (Energy Commission Report, 2017).

Solar power, abundant and renewable, harnessed from the sun through photovoltaic panels and solar thermal collectors, is a promising and increasingly accessible resource for generating electricity. It is a key player in our clean energy future (Sampaio & González, 2017; Ashok, S., 2021; Vaka et al., 2020).

A solar farm is an array of solar panels on open land that harnesses the sun's energy to generate electricity. Large utility-scale solar farms provide power for numerous homes and businesses, while individual homeowners install solar panels on their roofs to meet their energy needs. Similar to fossil-fuel plants, solar farms feed electricity into the grid (Watson & Hudson, 2015). Unlike traditional power plants, solar farms are environmentally friendly, producing no pollutants and requiring minimal water. Commercial photovoltaic (PV) solar farms typically use hundreds or thousands of PV panels to convert sunlight into electricity (Maka et al., 2021).

The transition to renewable energy in Malaysia faces challenges, including financial difficulties and a lack of incentives for utilities. Moreover, Malaysia's endeavors to promote renewable energy are regrettably falling behind in comparison to progressive initiatives witnessed across the globe. Nevertheless, there has been notable growth in the adoption of solar photovoltaic systems as a renewable energy technology in the country (Sreenath et al., 2020).

Contract administration involves overseeing and executing the contract process between a client and a contractor. In solar energy projects, this process is referred to as the "solar energy agreement," governing the relationship between the landowner and the party constructing and operating the project

(Prapanukool & Chaitusaney, 2020). These agreements are complex and have substantial economic implications (Solangi et al., 2011).

In short, this study reviews the existing literature on contract administration practices and contractual concerns specific to solar energy projects in Malaysia.

METHODOLOGY

This study undertakes an extensive literature review using the synthesis method. The synthesis method involves collecting and analyzing a diverse array of pertinent literature, academic papers, research studies, and reputable sources pertaining to solar energy contracts. Through this approach, the researchers identified two prevalent contract administration practices in Malaysia: Power Purchase Agreements (PPA) and solar leasing.

Furthermore, the synthesis method allows the researchers to shed light on several issues associated with solar energy agreements. These issues include delays, challenges related to contractual terms and policies, as well as financial concerns. By employing the synthesis method, the study provides a comprehensive and insightful analysis of the current state of contract administration in solar energy projects in Malaysia.

DISCUSSION

3.1 *Contract Administration*

Contract administration involves overseeing, negotiating, and executing contracts between clients and contractors (Grebenyuk, 2020). The "solar energy agreement" governs the relationship between landowners and entities constructing and operating solar projects, also known as solar leases or solar power contracts (Prapanukool & Chaitusaney, 2020).

Figure 3 Flowchart of roles contract administrator

contractual documents, identifies errors and risks, and ensures timely information flow. Proper contract administration ensures projects are completed on time, within budget, and with desired quality.

Effective contract management is crucial for strong corporate relationships and avoiding disputes. Failure to meet contractual criteria can lead to project delays and increased costs, resulting in disagreements and claims (Grebenyuk, 2020).

3.1.1 Power Purchase Agreement (PPA)

A Power Purchase Agreement (PPA) is a long-term contract signed by a buyer (electricity user) and a supplier (plant operator) for the supply of electricity at a set price. The profile of the electrical quantity may not be explicitly known. PPAs benefit both the buyer and the seller (ChungHongSik, 2018).

Using a PPA to finance a solar panel system is similar to leasing or "renting" the system. The solar firm or PPA financier pays for all costs related to purchasing and installing the solar equipment on the property. While the solar panel installation is on the property, they own it and are responsible for maintenance (Prapanukool & Chaitusaney, 2020).

Solar energy agreements are vital for managing relationships between landowners and parties involved in solar projects (Guideline, 2016). These agreements are complex legal contracts with significant economic implications (Choi & Kim, 2018).

Contract administration oversees contracts between clients and contractors, involving management, negotiation, and execution (Prapanukool & Chaitusaney, 2020). It ensures project compliance with

The Renewable Energy Power Purchase Agreement (REPPA) provided by SEDA consists of 13 clauses, as illustrated in the diagram below.
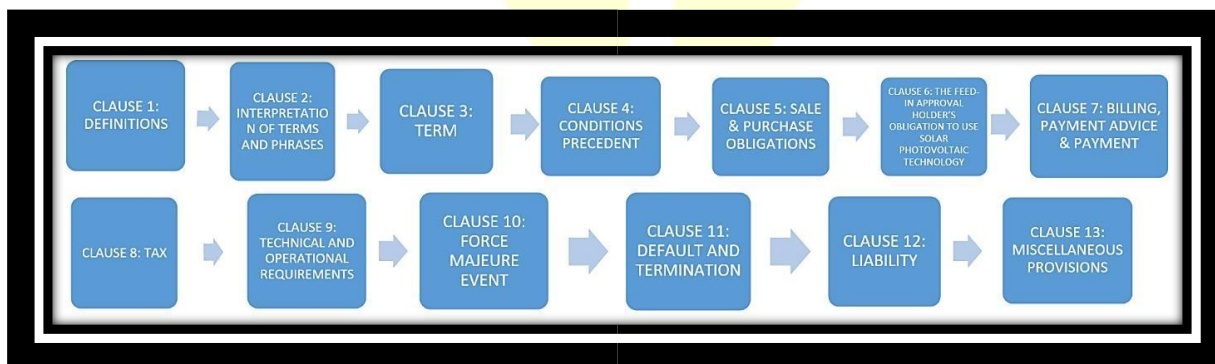
Figure 4 Clauses contained in the Power Purchase Agreement (PPA)

The Power Purchase Agreement (PPA) outlines a contract between a seller and a buyer for a specific amount of renewable energy at an agreed price over time. The first clause covers agreement definition, authorizations, feed-in tariff, and related aspects of solar PPAs (Guideline, 2016). The next clause focuses on contract interpretation, aiming to determine the parties' intentions and align with applicable legislation (Siddique, 2016).

The third clause involves contract terms, creating obligations that, if breached, can lead to legal action (Choi & Kim, 2018). The fourth clause discusses condition precedent, necessitating certain occurrences before parties commit to perform (Yune, 2021). Compliance with management ensures commitments are met in accordance with the law (Gutiérrez Aguilar, 2020). Clause five concerns sale and purchase obligations, specifying prices, exceptions for accepting renewable energy, and title and risk costs (Pangesthi, 2021). Clause six obliges the Feed-In Approval Holder to use compliant solar photovoltaic technology as per the Renewable Energy Act 2011 (Act No. 725 of 2011) (SEDA).

Billing, payment advice, and payment form the seventh clause, ensuring timely payments (Prapanukool & Chaitusaney, 2020). Clause eight addresses tax responsibilities (Nam, 2020). The ninth clause covers technical and operational requirements for smooth installation and development (Thiangtam, 2017). Finally, clause ten deals with force majeure events beyond parties' control, possibly leading to the agreement's termination (Guideline, 2016).

Clause 11 of the PPA covers default and termination, allowing either party to terminate the agreement with 14 days' written notice. Failure to provide notice constitutes a breach of contract and entails consequences (Clive, 2021).

Clause 12 discusses liability, holding each party responsible for their actions, including negligence or breach of the agreement. It also addresses consequential loss, limiting liability for indirect or punitive damages (Andriienko, 2021).

Finally, clause 13 contains miscellaneous provisions such as transfers, notices, successors, amendments, stamp duty, governing law, and dispute resolution. These provisions may be overlooked but are crucial as they govern remedies for contract breaches (Ge, Ji & Louis, 2020).

Figure 3 Flow of PPA contracts between parties in solar contracts (SEDA)

PPA rates vary monthly based on solar panel system production, unlike solar leases. Solar panels generate more electricity in summer, resulting in higher PPA payments but lower utility costs for customers during those months (Isaza Cuervo, Arredondo-Orozco & Marenco-Maldonado, 2021).

In Malaysia, PPAs are categorized into three types: PPA for Solar PV projects up to 1 MW, PPA for projects from 1 MW to 12 MW, and PPA for projects above 12 MW. The appropriate PPA is selected based on the project's size and requirements.

3.1.2 Solar Leasing

For small businesses, adopting solar energy may seem unattainable due to the high initial installation costs. However, solar leasing offers a solution, allowing businesses to go solar without upfront expenses (Song & Poh, 2017). Similarly, homeowners can choose to buy or lease solar systems from licensed distributors. Leasing has become popular because it eliminates the need for significant upfront payments and includes routine maintenance provided by the lessor. Additionally, for residential systems, leasing remains advantageous compared to purchasing due to the inability to benefit from tax benefits associated with solar equipment depreciation (Liu et al., 2014).
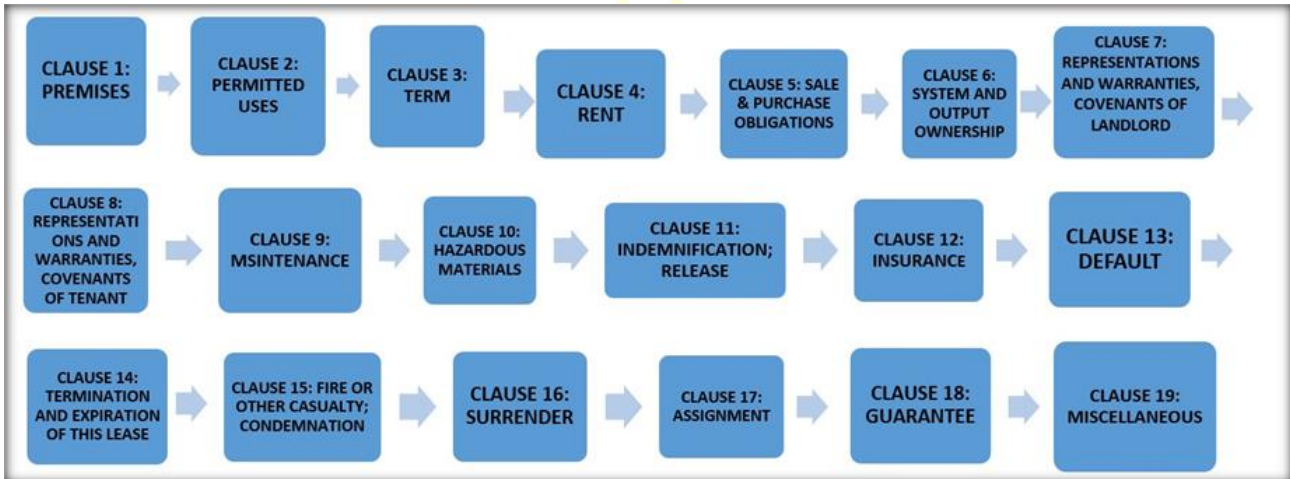
Figure 4 Clauses contained in the Solar Leasing Agreement (SEDA)

The solar leasing process in Malaysia involves contacting a Solar Leasing Program provider, who assesses the property's suitability for solar electricity. If the property qualifies, the provider may require a deposit and a 10 to 20-year agreement. During the contract, the provider handles installation, maintenance, and utility incentives. The Solar Leasing agreement typically contains 19 clauses that cover various aspects of the lease.

The clauses in the agreement cover premises, permitted uses, term, rent, system construction, ownership, representations, warranties, covenants, maintenance, hazardous materials, indemnification, insurance, default, termination, fire or casualty, surrender, assignment, guaranty, and miscellaneous provisions. Complying with these clauses is crucial to ensure a smooth and legally sound solar leasing process (Kalinina, 2021; Nengsih, Kristianto & Ariyanti, 2019).

3.2 Contractual Issues in Solar Projects

According to Oh et al. (2010), Malaysia has faced several challenges in transitioning to renewable energy, including financial difficulties, unappealing rates, and a lack of incentives for utilities. This research focuses on contractual issues related to delays, terms, policies, and financial aspects. Another concern with solar power purchase agreements is the potential difficulty in selling a property with an existing PPA, as new buyers may opt out, requiring the seller to either buy the system or find another buyer. The highlighted contractual issues arise from the complexities within solar energy agreements (Solangi et al., 2011).

3.2.1 *Delays*

In the PV sector, project delays have been identified as a potential cause of cancellations (O'Shaughnessy et al., 2020). In Malaysia, delays can occur due to failure to meet the requirements of the distribution licensee, TNB, which includes incomplete supporting documentation, drawings, and appendices, leading to contractual difficulties (Lesovoi & Globa, 2021). Delays in PV installation may also

arise from installers' issues in paperwork compilation and filing, design-related challenges, and variations in code interpretation and implementation across different locations (Sinitskaya et al., 2019).

Other contractual issues contributing to PV project delays involve poor coordination between installers and customers/buyers during contract discussions and site assessments, leading to about 12% of homeowners canceling their PV installation contracts (Liao, 2020). The lack of foresight in anticipating potential building phase issues can result in not only delays but also increased project costs and compromised quality (Latif et al., 2021). These contractual challenges require careful attention to ensure the successful implementation of solar PV projects.

3.2.2 *Terms and Policies*

Contractual issues with solar energy can be challenging, and even when an expert identifies the causes of system failings, settling alleged losses can be difficult due to their magnitude (Provenzano & Iddas, 2020). The lack of detailed information in the fifth-fuel strategy and green technology policy hinders progress, as these policies only outline objectives without clear measures for achieving a greener, sustainable development (Kamaruzzaman et al., 2012). A low level of awareness of government policies in Malaysia, particularly regarding the FIT scheme and solar PV, poses a barrier to the adoption of renewable energy (Muhammad-Sukki, Ramirez-Iniguez, Abu-Bakar, McMeekin, Stewart, et al., 2011). The general public's lack of awareness of national policies and incentives related to renewable energy further exacerbates the situation (Muhammad-Sukki, Ramirez-Iniguez, Abu-Bakar, McMeekin, & Stewart, 2011).

Contracts with numerous changes and amendments can lead to uncertainty, confusion, and potential conflicts over the interpretation and impact of contractual clauses (VanDemark & Clevenger, 2020). The unclear decision-making process for solar farming development clearance in Malaysia results in disagreements among land administrators, affecting the management of land for solar farming development (Azmi et al., 2020). These challenges contribute to the complexities of implementing solar energy projects in the country.

3.2.3 *Financial*

Financial challenges hinder Renewable Energy Power Purchase Agreements (PPAs) by providing insufficient cash flow for bankers, leading to reduced confidence in investment (Petinrin and Shaaban, 2015). Investing in photovoltaic systems through solar power purchasing agreements and leasing is not economically viable (Junlakarn & Kokchang, 2020). Establishing revenue contracts for renewable energy projects is challenging due to intermittency, resource uncertainty, and high technology costs, leading to increased project financing needs (Barroco & Herrera, 2019). Renewable energy is still considered immature, dangerous, and unproven in Thailand and Malaysia, impacting its adoption (Sovacool, 2010).

CONCLUSION

In conclusion, this review paper highlights contract administration practices and contractual concerns in solar energy projects in Malaysia. However, due to limited knowledge, further research is needed to address the complexities in this industry. This research is significant to improve industry practices, mitigate contractual risks, and accelerate the energy transition. Valuable insights from solar energy professionals are crucial to validate and enhance this investigation. Collaborative efforts between academia and industry can lead to a more sustainable and efficient solar energy sector, supporting Malaysia's energy transition and environmental goals.

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EXPLORE THE POSSIBILITY OF SHIFTING FACE-TO-FACE TO FULL ONLINE TEACHING FOR QUANTITY SURVEYING PROGRAMME

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ABSTRACT

Online teaching and learning bring enormous benefits to the education sector. It allows the education providers to be globalised when teaching and learning can be done from everywhere, overcoming space and time limitations as geography is no longer a barrier. It promotes flexibility for the learners to learn at their own pace and location. Research has been done on online teaching and learning based on specific disciplines, such as health psychology, mathematics, physics, STEM, and health science. Currently, there is little evidence showing the efforts undertaken by Malaysian higher education institutions to develop open online learning materials in the Quantity Surveying (QS) programme. Thus, this research paper aims to explore the possibility of shifting face-to-face to full online teaching for the QS programme by identifying the student's perception of the advantages and barriers of online learning implementation and the perception of offering QS core subjects using online. This research employed a quantitative research approach utilising a questionnaire survey that was participated by 110 quantity surveying students from universities in Malaysia. The quantitative data have undergone reliability and descriptive analysis. The finding shows the top three online teaching advantages are flexible learning environment, high accessibility of learning resources and flexible time. The top three online teaching barriers are lack of internet connectivity, social interaction and student demotivation. Overall, students are reluctant to switch study mode from face-to-face to full online teaching as all main categories of QS subjects, namely (1) Measurements, (2) Technology in Construction, (3) Cost Planning and Economics, (4) Professional Practice, Project Planning and Law and (5) Computer Technology and Software, collectively attained less than 3.00 mean value for the agreement level. The findings shed light on current students' acceptance of online teaching and learning and it can be used to improve the related course curriculum as a platform to offer full online QS courses in the future.

Keywords : Online learning, Online teaching, Quantity Surveying, Higher education

INTRODUCTION

There are approximately 30 universities and colleges offering Quantity Surveying programme in Malaysia, where the campuses are mainly located at Selangor, Kuala Lumpur, Johor, Negeri Sembilan, Pulau Pinang, and Sarawak (Board of Quantity Surveyors, 2023). The Quantity Surveying programmes offered in different higher education institutions inevitably comprised common core subjects. Five (5) main categories were found: Measurements, Technology in Construction, Cost Planning and Economics, Professional Practice, Project Planning and Law, and Computer Technology and Software Application.

For measurement, it comprises measurement for building, infrastructure, plumbing, electrical, and external works. The Technology in Construction includes subjects like Construction Technology, Building Services and Construction Technologies, Mechanical and Electrical Services, Site Surveying, Building Structural System, and Building Materials/Construction Materials. Common subject under the Cost Planning and Economics category: Estimating and Construction Economics, Property Development, Data Analysis and Cost Control, Financial Management, Development Economics and Value Management. Meanwhile, under the Professional Practice, Project Planning and Law, the universities offer common subjects such as Professional Practices, Contract Administration, Project Management, Value Engineering, Construction Law, and Legal Studies Lastly, common subject like a Technical Drawing and CADD, Software Application for Quantity Surveying, BIM and IT, Engineering Drawing, Computer Aided Quantity Surveying is categorised under Computer Technology and Software Application category.

Online courses began to be used in the educational fields in the mid-1990s and have expanded over the decades (Lee et al., 2009; Keengwe & Kidd, 2010). Online learning allows learning centers to be globalised when the classroom is no longer at one fixed location, where teaching and learning can be done everywhere. Thus, online teaching methods can promote flexibility, allowing local or international students to overcome space and time limitations (Keengwe & Kidd, 2010; Marasi et al., 2020).

Previous research highlighted the advantages of online teaching are flexibility in term of time (O'Donoghue et al., 2004; Arkoful & Abaidoo, 2014; Bailey & Lee, 2020; Coman et al., 2020; Al Rawashdeh et al., 2021; Narayan & Shailashri, 2021; Ghasem & Ghannam, 2021), flexible learning environment (O'Donoghue et al., 2004; Bailey & Lee, 2020; Coman et al., 2020; Ghasem & Ghannam, 2021), engage students in active learning (Bailey & Lee, 2020; Al Rawashdeh et al., 2021; Ghasem & Ghannam, 2021) cost effective (Arkoful & Abaidoo, 2014; Narayan & Shailashri, 2021) individualising and self-paced learning (O'Donoghue et al., 2004; Arkoful & Abaidoo, 2014; Ghasem & Ghannam, 2021), enhanced communication between students and instructors (O'Donoghue et al., 2004; Arkoful & Abaidoo, 2014; Al Rawashdeh et al., 2021), high accessibility of learning resources (Al Rawashdeh et al., 2021; Ghasem & Ghannam, 2021), and quality education (Al Rawashdeh et al., 2021; Narayan & Shailashri, 2021).

Despite numerous studies exploring the advantages of online learning, adopting full online learning raises several issues such as high initial cost (Bacow et al., 2012; Thanji & Vasantha, 2016; Islam & Habib, 2021; Pokhrel & Chhetri, 2021), lack of internet connectivity (Islam & Habib, 2021; Pokhrel & Chhetri, 2021), lack of quality assurance (Bacow et al., 2012; Islam & Habib, 2021; Bhatt et al., 2022), lack of technical support (Thanji & Vasantha, 2016; Islam & Habib, 2021), social interaction (Islam & Habib, 2021; Pokhrel & Chhetri, 2021; Bhatt et al., 2022), student readiness (Islam & Habib, 2021; Bhatt et al., 2022), and student

motivation (Islam & Habib, 2021; Bhatt et al., 2022).

The popularity of internet and the support from digital technology have promoted the development of online learning during the COVID-19 outbreak (Jin, 2020). Undoubtedly, COVID-19 accelerates the move toward the online environment. It was an untested and unprecedented event when universities and learning centers had to move to online classes to keep functioning even if they did not feel adequately prepared.

Similarly in Malaysia, higher education providers had to switch to full online mode, creating a sense of panic and a lack of preparation to change the new teaching and learning mode. Even though some universities had been using online teaching and learning (OTL) platforms for teaching activities before the pandemic, most were not ready for a wholly online experience (Coman et al., 2020). Likewise, the Learning Management System as a teaching platform is merely for disseminating course information/content and is not used for full online classrooms (Mahbub, 2016; Bryson & Andres, 2020). Adopting online learning during the COVID-19 crisis seems to be an abrupt response to the crisis, which was refers to emergency remote teaching (Bozkurt & Sharma, 2020). Everything is believed to be temporary and supposed to return to normality after the emergency (Bryson & Andres, 2020).

Most of the studies highlighted the guideline for conducting online classes (Martin et al., 2019; Bryson & Andres, 2020; Cutri et al., 2020; Marasi et al., 2020) with focusing on the lecturers and faculties, but limited studies on the student's perspective. Martin et al. (2019) and Cutri et al. (2020) addressed the faculties' readiness for online teaching and learning. Marasi et al. (2020) highlighted the faculty satisfaction in online teaching and learning. In contrast, Scherer et al. (2021) and Paliwal and Singh (2021) have explored online teaching and learning readiness in a general view and are not specific to a subject discipline. A few

research have been done on a particular field, such as health psychology (Yen, 2020), mathematics subject (Cao et al., 2021), physic (Ndihokubwayo et al., 2020), STEM (Tang et al., 2020), health science (Janse van Rensburg, 2018). However, limited studies have shown the online teaching in built environment studies generally and Quantity Surveying (QS) specifically. Currently, there is little evidence demonstrating the efforts undertaken by Malaysian higher education institutions to develop open learning materials in the QS educational framework (Mohamed et al., 2018). This may be due to QS course nature which needs the integration, cohesive and dynamic teaching and learning environment in the traditional classroom (Board of Quantity Surveyors, 2020).

Covid-19 accelerated establishing the accreditation manual for the online QS programme in January 2021 (Board of Quantity Surveyors, 2021). This manual shows the QS professional bodies are ready to receive an application from higher education institutions to conduct their online programme. However, to date, none of the universities offered the full online QS programme (Board of Quantity Surveyors, 2023).

Thus, it is worth exploring the possibility of offering QS programme in full online mode permanently in the future. Full or whole online learning is supported by technology and devices like computers, laptops, tablets and mobile phones with internet access (Selvanathan et al., 2020) and has no element of the traditional face-to-face learning method.

This study focuses on the students. Their feedback as the end user is the excellent indicator for the effectiveness of online learning implementation. Some aspects of online learning and student viewpoints are still unclear. Does whole online teaching for quantity surveying beneficial? What are the critical barriers in adopting online learning courses? Is it possible to shift face-to-face to fully online teaching for the quantity surveying

programme? Therefore, this study perceived the students' response on the possibility of offering QS in full online permanently in the future based on their experience of online teaching and learning during the pandemic.

MAIN RESULTS

110 questionnaires were collected from the quantity surveying students with experience of full online classes. The obtained data met the internal consistency with the Cronbach's alpha value is more than 0.80. Understanding the advantages of full online learning and the barrier to online learning implementation is vital to assess the students' perspective on the possibility of offering full online courses in the QS programme. Table 1 depicts the mean rank for advantages of full online teaching for the Quantity Surveying Programme. Table 2 shows the mean rank for key barriers in adopting full online teaching for Quantity Surveying Programme.

Table 1 Mean Ranking for Advantages of Full Online Teaching for Quantity Surveying Programme.

Description	Ranking	Mean	Std. Deviation
Flexible learning environment	1	4.4273	0.66992
High accessibility of learning resources	2	4.4091	0.70770
Flexibility in time	3	4.3909	0.71799
Individualizing and self-paced learning	4	4.2636	0.72539
Cost-effective	5	4.2091	0.77927
Quality education	6	4.1818	0.81479
Engage students in active learning	7	4.0364	0.90794
Enhanced communication between students and instructors	8	3.8909	0.98935

The top three ranked advantages are "Flexible learning environment," "High accessibility of learning resources," and "Flexibility in time". Online teaching empowers the students to choose where the learning environment is, regardless of whether it is an enclosed area, open area, or even outdoors. Furthermore, online learning materials can be said to be available and accessible all the time from anywhere, without attending physical classes at specific times. It incorporates a wide range of information, multimedia resources, and learning materials such as e-books, academic journals, and research papers as additional aids to a student's learning. Online classes also do provide time flexibility for students. They can conduct learning activities whenever they feel ready to and are not constrained by the physical limitation of commuting to the campus. Simultaneously, it gives impetus to saving both time and money.

Table 2 Mean Ranking for Key Barriers in Adopting Full Online Teaching for Quantity Surveying Programme.

Description	Ranking	Mean	Std. Deviation
Lack of internet connectivity	1	4.1091	1.02577

Description	Ranking	Mean	Std. Deviation
Social interaction	2	4.0636	0.90135
Student motivation	3	4.0545	0.91708
Lack of quality assurance	4	4.0091	1.02711
Lack of technical support	5	4.0091	1.01814
Student readiness	6	3.9091	1.01859
High initial cost	7	3.8636	0.98127

The results have revealed 'Lack of internet connectivity' is the predominant barrier to adopting full online teaching classes. Online classes rely on the internet and require a reliable connection for students to access course materials, participate in discussions and submit assignments or online assessments. Students who lack access to high-speed internet or live in areas with limited internet connectivity may not be able to fully participate in online courses, causing a reduction of the efficiency to learn and succeed in their studies. Another key barrier is the "lack of social interaction". This issue leads the students to feel disengaged and isolated; gradually, it discourages them from learning, especially those who did not get involved in the discussion held due to the poor internet connection. They also face difficulties creating deep communication and strong relationships when using online as compared to what they get in face-to-face communication. Not far behind, the third rank is "Student motivation". This barrier is interlinked with "Social interaction". It is because social interaction plays a significant role in influencing student motivation. When students have opportunities to interact socially with their peers and teachers, they can experience a sense of belonging and connectedness to the learning environment. This can help foster a positive attitude towards learning and increase student motivation.

After figuring out the advantages and key barriers to adopting full online teaching, it is necessary to assess the possibility of shifting face-to-face to full online teaching for the quantity surveying programme. Table 3 shows the student's feedback on the possibility of offering QS core subjects in full online.

Table 3 Mean Ranking for Possibility of Shifting Face-to-face to Full Online Teaching for the core subject in the Quantity Surveying Programme.

Description	Code	Ranking	Mean	Std. Deviation
Cost Planning and Economics (Estimating, Development Economics, Financial Management, Construction Financial Practice, Value Management, Data Analysis and Cost Control)	D3	1	2.6000	1.36939
Professional Practice, Project Planning and Law (PPP, Contract Administration, Project Management, Value Engineering, Construction Law, Legal Studies)	D4	2	2.5091	1.37971

Description	Code	Ranking	Mean	Std. Deviation
Computer Technology and Software (CADD, CAQS, Engineering Drawing, BIM and IT)	D5	3	2.3545	1.37865
Technology in Construction (Building Services, Construction Technology, Building Materials and Site Surveying)	D2	4	2.3364	1.33600
Measurements (I,II,III and Civil Works)	D1	5	2.2545	1.30234

Based on data in Table 3, the degree of agreement in shifting the quantity surveying subjects into full online is low. Each category has a mean of less than 3.000. Amongst five (5) categories, **D3 and D4** category has the highest potential to be shifted from face-to-face to full online teaching. It is because subjects related to cost planning economics, professional practice and legal studies are considered theory-based, where it can often be shifted to online as theory-based courses do not need hands-on practical experience and face-to-face demonstration, primarily involving the transmission of the knowledge.

D5 and D2 scored lower ranks. The subject listed under these categories, Computer Technology and Technology in Construction requires physical equipment, hands-on labs, practices, or site visits. Although virtual simulation is provided, it may not be the same as actual experience. **D1** has the lowest mean ranking, which also conveys that the measurement subjects in quantity surveying are the least likely to be shifted to full online teaching. Unsurprisingly, students might experience challenges in visualising or imagining the building's components and dimensions through online platform; they could not conceive a clear picture of a building at that moment.

Furthermore, students were asking their learning style preferences. Figure 1 illustrates the percentage of students' preference in selecting teaching mode, whether full online or face-to-face. Figure 2 reveals the possibility of shifting face-to-face to full online teaching for the quantity surveying programme.

Referring to Figure 1, more than 50% of students choose to remain in face-to-face class. Meanwhile, Figure 2 shows 60% of respondents are unhappy if all their subjects are conducted in full online mode.
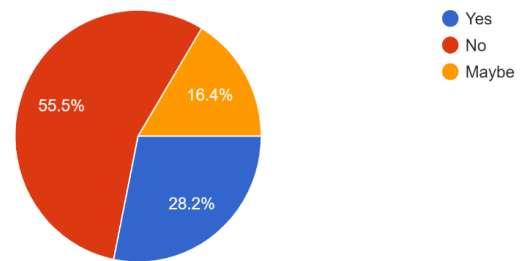
Figure 1 The Student's Preference of Class Teaching Mode.
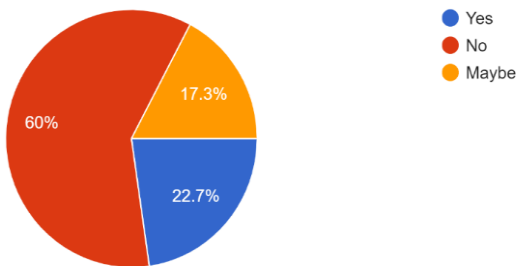
Figure 2 The possibility of shifting face-to-face to Full Online Teaching for Quantity Surveying Programme.

The results revealed that the students still prefer offline face-to-face classes because of the opportunities for social interaction, structured learning environments, hands-on learning, personal attention, and the limitations of technology. Despite the potential benefits of online learning, majority of students still reluctant to have full online classes for various reasons. Students may not be ready or entirely

comfortable with online learning. In summary, the student values the barriers in adopting full online more over the advantages that full online teaching could bring.

CONCLUSION

This study pinpoints the significant advantages, key barriers in adopting full online teaching, and the possibility of shifting face-to-face to full online teaching for quantity surveying programme. The findings are expected to contribute to the education sector, not merely to quantity surveying programme but also to other similar programmes, such as mathematics and engineering studies which require more hands-on activities. The higher education institutions would know what the challenges in online learning from the perspective of end user i.e. students, thus, they can make a proper mitigation plan to overcome those challenges as an effort to offer full online courses. The lecturers also benefited as they know the advantage of having online classes, thus they can deliver theoretical-based subjects online. For students, the insights of this research paper provide valuable information in considering which learning style is suitable for their subject to get the maximum effective outcome.

With the benefits of full online teaching and learning, studying how to increase the possibility of teaching technical subjects such as Technology in Construction, Computer Aided and Measurement online is recommended. The new technologies in Augmented Reality, Virtual Reality or Mixed Reality could be adopted to aid the learning process and thus become a successful factor in offering full online QS courses.

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GEOINFORMATION

APPLICATION OF LOCAL DERIVED IONOSPHERIC MODEL IN SOLVING AMBIGUITY OF BASELINE: PRELIMINARY STUDY

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ABSTRACT

The Global Positioning System (GPS) carrier phase measurement not only contained the geometric range from the satellite to the receiver but also consists of several types of errors such as ionospheric error, tropospheric error, multipath, hardware error, and multipath. To obtain accurate and precise GPS positioning and navigation applications, those errors need to be minimized. In this study, we focused on ionospheric error as conditions of the ionosphere highly affect the accuracy of GPS positioning and navigation applications, especially over the equatorial/low-latitude region. Apart from using a dual-frequency linear combination ionosphere-free, this error can be minimized by implementing an appropriate ionospheric model, especially for solving the ambiguity resolution. To demonstrate the effectiveness of the ionospheric model, we derived the local ionospheric model from local GPS networks over the Malaysian region to assess their performances in solving the baseline ambiguity. The assessment is based on the improvement of the percentage of ambiguity resolution during the occurrences of geomagnetic storms. The results are expected to demonstrate the percentage improvement of ambiguity resolution from the locally derived ionospheric model.

Keywords: Global Positioning System (GPS), Ambiguity Resolution, Local Ionospheric Model.

INTRODUCTION

The Global Positioning System (GPS) is known for its capability in providing position, velocity, and time (PVT) solutions with enhanced accuracy and reliability for navigation and positioning applications. However, its accuracy and precision

may be degraded as its measurements are affected by time delay caused by other factors such as an ionospheric layer, tropospheric layer, multipath, and others as simplified in the GPS carrier-phase observations equations below (Hoffman-Wellenhof et al. 2008):

$$\phi_1 = \rho + c(dt^s - dt_r)_{\phi_1} - d_{ion_{\phi_1}} + d_{trop_{\phi_1}}$$
$$+ (dH^s + dH_r)_{\phi_1} + d_{mp_{\phi_1}}$$
$$+ \lambda_{\phi_1} N_{\phi_1} + \varepsilon_{\phi_1}$$
$$\phi_2 = \rho + c(dt^s - dt_r)_{\phi_2} - d_{ion_{\phi_2}} + d_{trop_{\phi_2}}$$
$$+ (dH^s + dH_r)_{\phi_2} + d_{mp_{\phi_2}}$$
$$+ \lambda_{\phi_2} N_{\phi_2} + \varepsilon_{\phi_2}$$

where ϕ_1 and ϕ_2 represent the GPS carrier-phase measurements, ρ is the geometric range from satellite to receiver, c is the speed of light, dt^s and dt_r represent the satellite and receiver clock delay respectively, d_{ion} is the ionospheric delay, d_{trop} is the tropospheric delay, d_{mp} is the multipath, λ is the wavelength, N is the carrier phase integer ambiguity and ε represenrs the signal noise.

Since the ionosphere is known as one of the major errors in GPS measurements, the dual-frequency linear combination ionosphere free is usually used to minimize or remove the ionospheric error specifically for first order (Hoque and Jakowski 2008). However, the higher order remains in the range estimation, and this affects the accuracy of the GPS observations and applications (Liu et al. 2016; Xi and Wang, 2021), which can be up to tens of centimetres (Datta-Barua et al. 2008).

Even though this range of errors can be neglected by most applications, however, for geodetic applications particularly, this error needs to be removed by using the existing ionospheric model such as Global Ionospheric Maps (GIM), especially when involved with solving carrier phase ambiguity. This is due to further improving the ambiguity resolution performances.

The suitability of the ionospheric model also plays an important role in further improving the ambiguity of the baseline. The existing global model such as GIM has been used widely, especially when involved the high-precision processing software. This model is known to have good accuracy ranging from 2 to 8 TECU (de Oliveira et al. 2020).

However, there is a need for the derivation of the local ionospheric model since the global model best describes the global conditions only. It is expected that the implementation of the local ionospheric model, which has good accuracy will be capable of further improving the ambiguity resolution especially for medium and long baselines (See Wang and Rothacher 2013; Paziewski 2015). Furthermore, the performances of the ionospheric models also depend on the current ionospheric conditions (Tang et al. 2016) since this may affect the efficiency of the ambiguity resolution, especially for medium and long baseline.

Previous studies have demonstrated that the application of stochastic ionospheric model from local network can further improve the GPS ambiguity resolution estimations (Julien et al. 2004). Later, Silva et al. (2020) also demonstrates the improvement of the local derived ionospheric model in solving the GPS ambiguity resolution especially during the presence of weak and strong ionospheric activities.

Over the Southeast Asia, especially Malaysia region, there still lack of introduction and discussion on the local ionospheric model. Therefore, in this study, we assessed the capability of the ionospheric model derived from the local Malaysian Real-time Kinematic Network (MyRTKnet) in solving the ambiguity resolution. In doing so, we formed 4 types of baselines consisting of medium, long, and very long baselines to evaluate the improvement in ambiguity resolution percentage during the occurrences of the geomagnetic storms.

METHODOLOGY

In this study, we focussed on improving the ambiguity resolution percentage using the locally derived ionospheric model during the occurrences of geomagnetic storms. Adopting the method from Khamdan et al. (2023), first, we derived the local ionospheric model from local GPS CORS stations, MyRTKnet over the Malaysian region using the Bernese Software Version 5.2, which will be applied for baseline processing.

There are 4 types of baselines that are formed which consist of medium (<500 km), long (<1000 km), and very long baselines (>1000 km). In this study, we did not focus on the baseline length of less than 100 km, as in a short baseline since it is known to have fair ionospheric conditions (Li et al. 2018).

Noted that, for a very long baseline, it consists of 2 types of baselines which are baseline forming inside the generated region of local ionospheric model, while another is formed outside the generated region. This allows us to demonstrate the improvement rate of ambiguity percentage while using the local ionospheric model. Figure 1 maps the baseline formation that involved in this study.
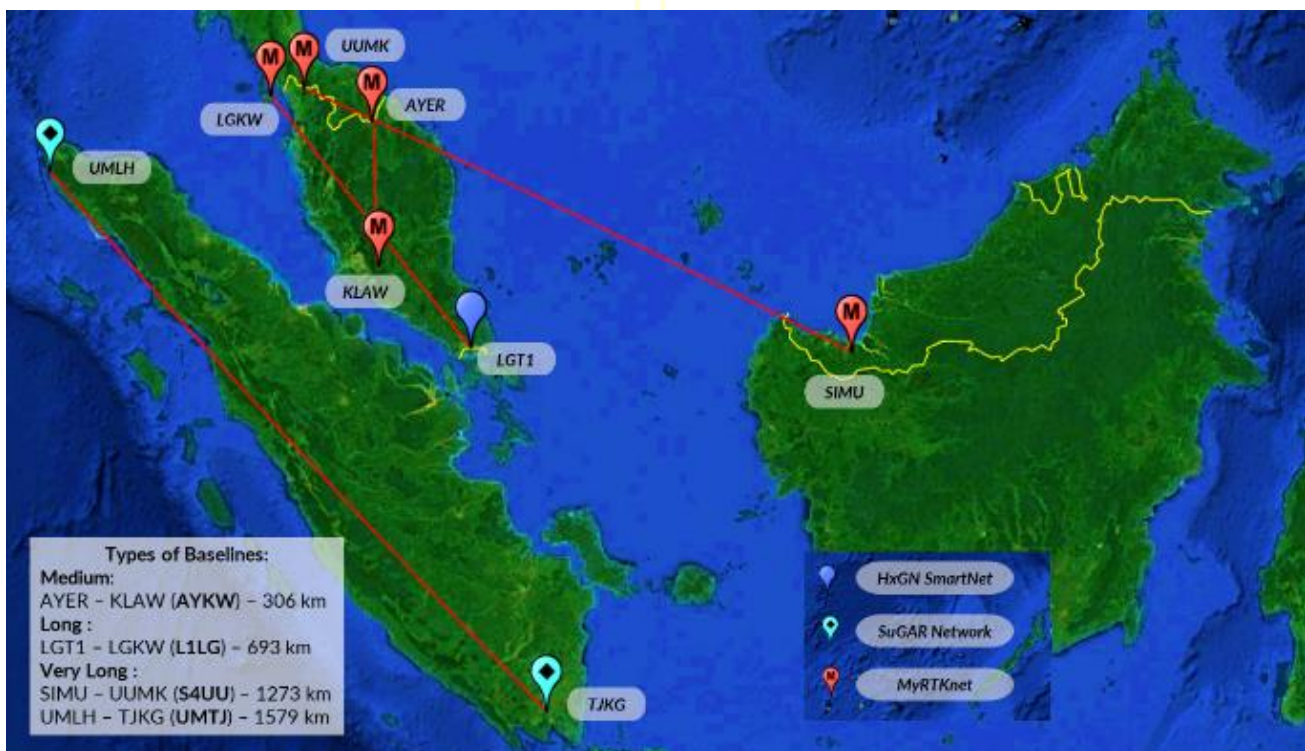
Figure 5 The formation of the baselines that are involved in this study.

Table 1 Baseline processing strategy during the application of the ionospheric model.

Processing strategy and parameter estimation		Description
Ambiguity resolution strategy	QIF using an ionosphere-free linear combination	QIF strategy resolve L1 and L2 ambiguities directly without using code measurement.
Sampling rate	30 second	Sampling rate of GPS observation.
Elevation mask	15°	Elevation mask that was used to resolve ambiguity.
Ionosphere	Without ionospheric	The models were used to assess

Model	model	the improvement in solving ambiguity resolution. The local ionospheric model derived from GPS local network, while the global ionospheric model retrieved from CODE análisis center.
	Local ionospheric model	
	Global ionospheric model	

The assessment of the local ionospheric model is carried out together with the global ionospheric model, GIM. The results will be compared with the baseline processing without applying any ionospheric model and serve as a benchmark to monitor the improvement in ambiguity resolution percentage by both models. The study period consists of 9 days, from 28th August (DoY 240) until 5th September (DoY 248). Table 1 tabulates the strategy for baseline processing.

RESULTS AND DISCUSSION

In this study, we assess the improvement of the local ionospheric model during the occurrences of geomagnetic storms. It has been reported that a G1 level geomagnetic storm occurred on 31st August 2019 and G2 level on 1st September 2019. It was recorded by Space Weather Prediction Center (SWPC) the Kp-index values for both days are up to 6, with the Dst-index value recorded down to -50nT.
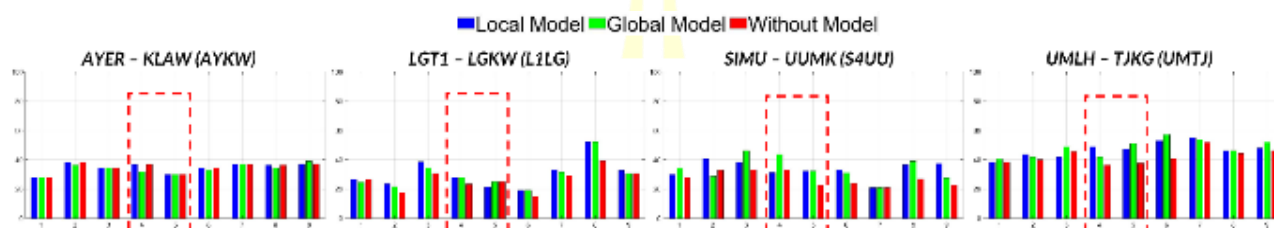
Figure 6 Percentage of ambiguity resolution for the GPS baselines. The dashed red box represents the day with occurrences of geomagnetic storms.

Figure 2 shows the percentage of ambiguity resolution for all baselines during the study period. Overall, an improvement in the percentage ambiguity resolution was found for both ionospheric models. The deterioration of the ambiguity resolution percentage was also observed with an increase in the baseline lengths. This is due to the different ionospheric conditions between stations (Deng et al. 2020).

A minimum percentage ambiguity resolution was found for the days with geomagnetic storms, with an average value of less than 40% especially for medium and long baselines. This is due to the occurrences of geomagnetic storms, which disturbed the normal conditions of the ionosphere and lead to the minimum percentage ambiguity resolution.

The results also show minimum differences between both ionospheric models for all baselines. For medium and long baselines, it can be observed that the local ionospheric model slightly further improved the ambiguity resolution percentage compared to the global ionospheric model. Meanwhile for both very long baselines, the local and global models almost similarly further improved the ambiguity resolutions percentage.

The performances of the global ionospheric model are undeniably suitable for improving the ambiguity resolution percentage for local areas. However, from the results of this study, the locally derived ionospheric model also can serve a similar purpose as the global ionospheric model, especially for a baseline length of less than 1000 km. This study can be one of the initiatives in developing the local

ionospheric model over the Malaysia region.

CONCLUSION

In this study, we presented the assessment on the local derived ionospheric model in solving the ambiguity resolution of the baseline. The assessment are carried out during the occurrences of the geomagnetic storms, and the application of the local ionospheric model are carried out together with the existing global ionospheric model. Overall, the percentage of ambiguity resolution for all baselines are found mínimum during the occurrences of the geomagnetic storms. the application of the local ionospheric model served the purposes similar with global ionospheric model, where the model able to further improved the ambiguity resolution percentage, especially for baseline less than 1000 km. To observed the accuracy and precisión of the positioning from the local ionospheric model, it is suggested that further investigation to be carried out on the baseline vector and station repeatability.

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RELIABILITY OF THE GNSS CARRIER-PHASE REAL-TIME KINEMATIC FIX SOLUTIONS FOR ON-THE-FLY OBSERVATION

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ABSTRACT

Modern surveying employs extensive use of Global Navigation Satellite System (GNSS) Real-Time Kinematic (RTK) techniques due to their ability to resolve carrier-phase ambiguity in just a short period of time. This single-epoch GNSS RTK positioning is highly dependent on the correct ambiguity resolution, as it will convert the measurement to centimetre levels, once the ambiguity has been resolved to its integer values and produce the RTK fixed solutions. However, in a moving receiver, the process of resolving ambiguity becomes more challenging by the inconsistency of the sky view for data observation, resulting in dubious solutions. Employing several reference stations is proposed as quality control when performing RTK surveying. Each generated coordinate will be compared with set of coordinates from other reference station to ensure the reliability of the fixed solutions. These are going to help in preventing the adoption of a false fixed solution.

Keywords: Real-Time Kinematic, Ambiguity Resolution, Integer Ambiguity

INTRODUCTION

GNSS positioning, is based on determining the distance between satellites and a receiver. To obtained a milimetre level accuracy, carrier-phase measurements are one of the best method available. The issue with carrier phase measurements is that each carrier phase has an ambiguous integer number of wavelengths.

Ambiguity resolution is described as the process of resolving unknown carrier phase cycle ambiguities to estimate the integer nature of the ambiguities, which is generally done in three (3) phases (Teunissen 2003). In the first phase, a normal least-square adjustment is performed to output float solutions, i.e., real number of ambiguity value, and their variance covariance matrix. The real valued float solution of the ambiguity is further modified in the second phase to accommodate for the integer restriction. Consequently, a set of integer ambiguity values is obtained. The Integer Least

Square (ILS) technique is one the best approach for integer estimation in practice (Atiz et al. 2021).

The ambiguity validation procedure is carried out in the third phase after the integer ambiguity has been resolved, by checking the best and second best of the sets of integer candidates to ensure that the integer value is correct (Verhagen 2016). There are several ambiguity validations tests, including the integer aperture (IA) estimator, ratio test, F-ratio test, W-ratio, difference test, and projector test, with the ratio test presently being the most prevalent (Li and Wang 2012). However, because the statistical characteristics of ambiguity do not truly follow the normal distribution function, ambiguity validation remains an unresolved topic and further research is needed (Feng and Jokinen 2017; Verhagen 2016, 2004).

METHODOLOGY

A test was conducted at Universiti Teknologi Malaysia, to demonstrate the reliability of a fix solution for on the fly GNSS RTK observation. For 5 minutes, GNSS RTK observation was carried out at a specific location under harsh condition as shown in Figure 1. Two (2) base stations were used, with one acting as a checking base station, using RTK module in RTKLIB.
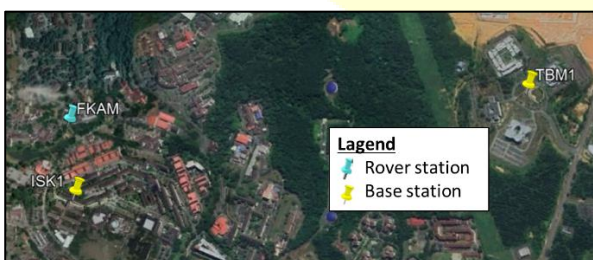
Figure 1 Distribution of rover and base stations.

The computer streamed observation data from the base stations and the rover receiver. Two (2) RTKnavi modules were used to process the rover's position in reference to the two (2) base stations. The estimated coordinates were compared with the known rover station coordinates.

The 3D distance between an estimated coordinate and a known point will be examined.

MAIN RESULTS

Based on Figure 2, baseline with respect to base TBM1, the algorithm was unable to resolve the ambiguity to its integer value during the observation. This leading to the acquisition of the float solutions throughout the observation. At the halfway of the observation, baseline in relation to ISK1 was able to get a fixed solution until the time end.

Figure 3 revealed that the fixed solutions found with respect to base ISK1 were an incorrectly fixed solution. Base ISK1 was the only base for which the fixed solution could be obtained from observation, whereas base TBM1 yielded float solution. The software recorded the solution as a fixed solution despite the solution having a significant mean coordinate difference at around 2 metres. Based on these findings, fixed solutions with respect to base ISK1 are regarded as false fixed solutions.

CONCLUSION

All available ambiguity validation test have statistical problems, but they still fulfil the user's needs. Although the points were observed under difficult conditions, the advanced and newest processing technique incorporated in the processing programme was capable of resolving the ambiguity to its integer value. Yet, due to an incorrectly estimated integer value, the fixed solution obtained may at times be false. As a result, a practical verification technique involving the use of a second base station to confirm the obtained coordinates is required. An additional base station will aid in determining the incorrect fixed solution and the reoccupation of that station. However, because this method has only been tested on static receiver, more research is needed to extend this validation method to moving receiver.

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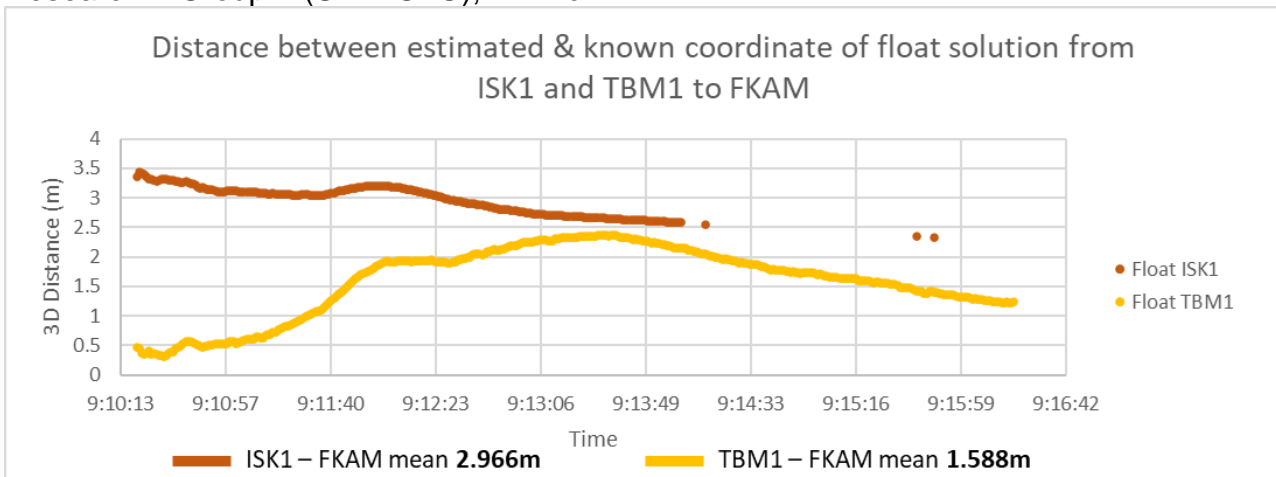
Figure 2 3D distance between estimated and known coordinate of float solution from ISK1 and TBM1 to FKAM.
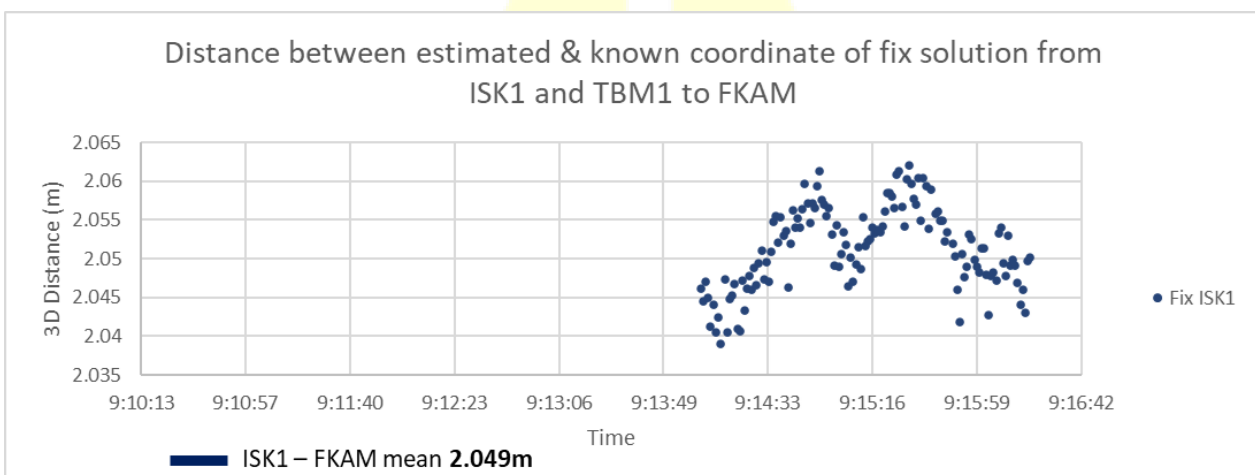
Figure 3 3D distance between estimated and known coordinate of fixed solution from ISK1 and TBM1 to FKAM.

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DETECTION OF FAR-FIELD SEISMIC WAVE USING SEISMOMETER AND GPS CORS: 2018 SULAWESI EARTHQUAKE 7.5 MW

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ABSTRACT

This study aims at investigating the performance of Global Positioning System (GPS) Continuous Operating Reference Station (CORS) and seismometer to determine time of arrival (TOA) and path velocity (PV). For detection of far-field seismic wave, these sensor enable to generate high rate time series displacements and has the capability to detect seismic wave during occurrence of Sulawesi earthquake 2018. The seismic wave such as body wave and surface wave can be analysed based on their characteristic of TOA and PV. Time series displacements can be treated as seismic wave that allow for picking TOA. Seismometer and high-rate GPS data in Sabah and Sarawak will be used to analyse PV. The finding show that the estimated TOA is within 10.0606 UT to 10.0837 UT according to the distance between epicenter and sensor. Meanwhile, the estimated PV is within range of 6.9656 km/s to 11.4183 km/s. The seismic PV were validate with other research that mentioned the seismic surface wave velocity within range of 6 to 13 km/s. It can be expected that this study will be beneficial towards rapid determination of earthquake epicenter for preparing geohazard warning system.

Keywords : Earthquake, GPS CORS, Seismometer, Seismic wave

INTRODUCTION

Malaysia is located around Sunda plate that are closed to the high seismicity zone (Shah et. al., 2021). Movement of tectonic plate around this area can caused an earthquake (Hapsoro et. al., 2023). Based on information from United States Geological Survey (USGS), Sulawesi earthquake 7.5 Mw was occurred on 28 September 2018 at 10:02:45 UTC of Palu, Indonesia as a result of a strike-slip fault.

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Mainly, strike-slip earthquake produce large horizontal displacements compared to vertical displacements (Zhang et. al., 2021). This earthquake was felt as far as Tawau, Malaysia (Vervaeck, 2018; USGS, 2023).

Seismic activities in Peninsular Malaysia and Borneo regions are being monitored by the Malaysia Meteorological Department (MMD) (Loi et. al., 2018). While, GPS CORS from Malaysia Network Real-Time Kinematic (MyRTKnet) provide coordinate time series displacement or ground shaking information, that might can be used to improve earthquake information in Southeast Asia (Shu et. al., 2018; Amirrudin et. al., 2020; Tongkul, 2021). It is proven that to improve the effectiveness in studying earthquake, the distribution and more number of sensor is needed (Lu et. al., 2018). This research aim to detect far-field seismic wave from earthquake using GPS CORS and seismometer. Data from these sensors will provide time series displacement during earthquake occurrence. The results of this study are expected to be useful parameters for estimates earthquake's epicenter and earthquake hazard warnings in the future.

DATA AND METHOD

This section discusses on data from sensors and methodology to determine seismic wave TOA and PV. Figure 1 show the methodology of this study.
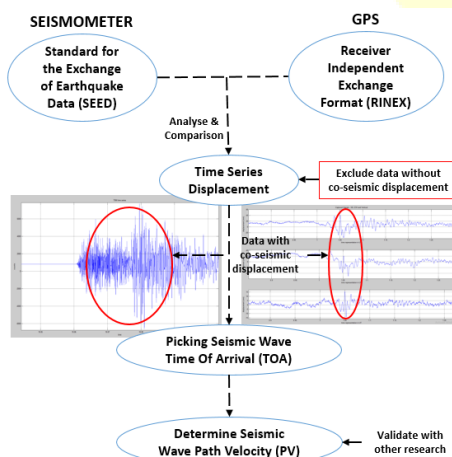
Figure 1 Methodology of this study

This study uses GPS data at two (2) MyRTKnet stations and two (2) MMD stations in Sabah and Sarawak, Malaysia. These stations were selected with estimated distance between 600 km to 900 km from epicenter location (geographical coordinate: 0.256°S 119.846°E). Figure 2 show the location of these sensors.

The first step is to picking the seismic wave time of arrival (TOA) as detected by GPS CORS and seismometer. The TOA was selected based on their amplitude from the waveform of time series displacement. The time series displacement from GPS CORS data produced from GPS processing by using software Bernese 4.2. Meanwhile seismic wave from seismometer data were given directly from the station and the TOA was estimated by using Matlab software. Incorrect picking TOA will introduce inaccurate estimation of PV as well as earthquake's epicenter location estimation (Massinai et. al., 2019). Multiple measuring TOA is necessary to avoid mistake during selecting the TOA.

From the TOA, time difference indicates travel time of seismic wave from the epicenter can be calculated as follow:

$$\Delta TOA = TOA_i - t_o \qquad (1)$$

Where, TOA_i is the TOA of seismic wave and t_o is the earthquake origin time (information from USGS). Then from the ΔTOA, we can calculate the PV as follow:

$$PV_i = \frac{d_i}{\Delta TOA} \qquad (2)$$

Where d_i is three-dimensional distance between epicenter and sensor location.
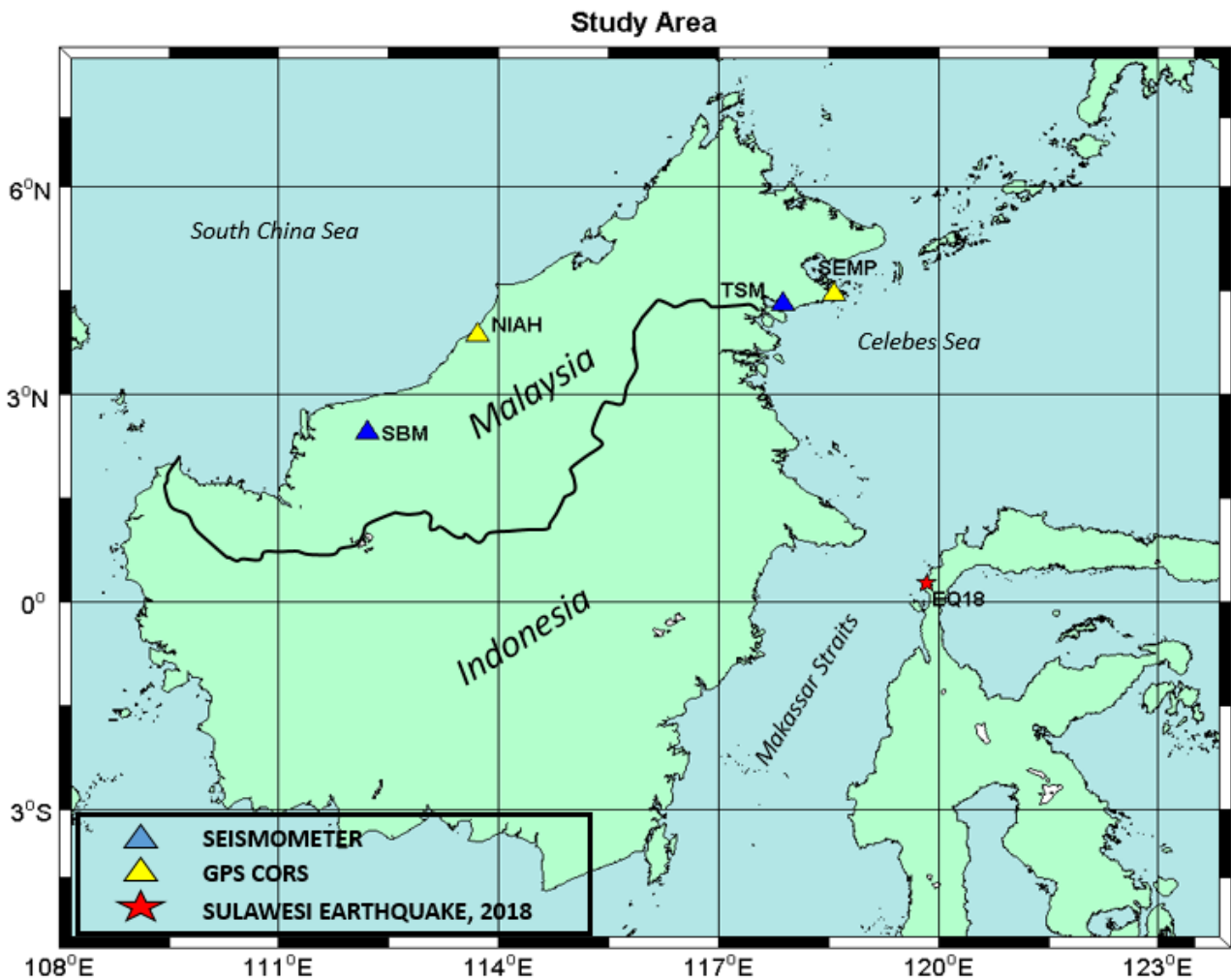
Figure 2 Distribution of GPS CORS and seismometer (yellow triangle represent GPS CORS, blue triangle represent seismometer and red star is epicenter)

RESULTS AND DISCUSSIONS

TOA at GPS CORS and Seismometer in Malaysia Borneo Region

The result show that the waveform of displacement captured on seismometer but not captured by GPS CORS. To further investigate the seismic wave TOA and PV, GPS CORS data were excluded in this case. Figure 3 and 4 shows the time series displacement from GPS CORS at site SEMP and NIAH (10.0 UT to 10.4 UT), respectively.

The occurrence of this condition may be due to the frequency and the distance between the sensors to the epicenter is far (Shu et. al., 2018). The strength of earthquake magnitude and noise can also be the reason why sensors unable to detect and capture seismic waves (Geng et. al., 2018). Moreover, the characteristic of the earth surface can be the main reason of the seismic wave being attenuate (Padhy & Subhadra, 2013). These criteria need to be addressed to minimise error in detecting and capturing seismic wave.

The next step is picking the seismic wave TOA. Figure 5 and 6 show the time series displacement from seismometer at site TSM (10.0 to 10.2 UT) and SBM (10.0 to 10.4 UT), respectively. The time series show significant change in waveform after 10:02:45 UTC (10.0485 UT hours). This indicate that seismometer has

successfully capture seismic wave displacement for Sulawesi earthquake 2018. From the time series, the first amplitude of waveform is the P-wave and the second amplitude is the S-wave. These P and S-wave can be categorised as a seismic body wave.
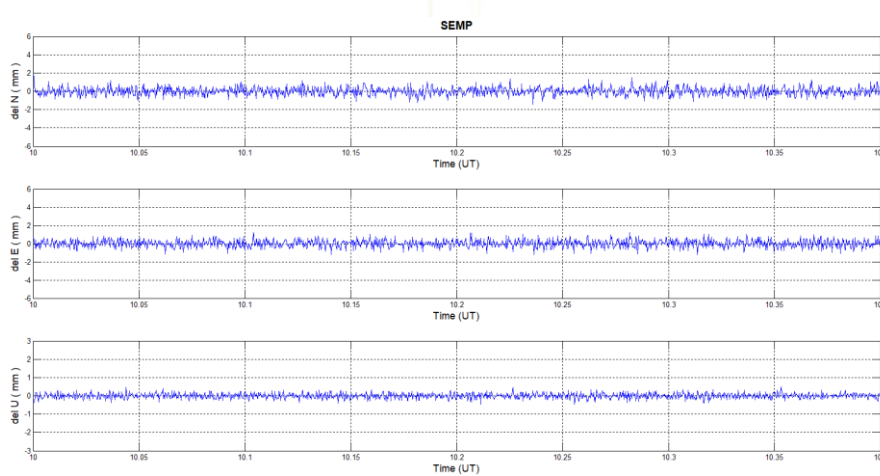
Figure 3 The time series at site SEMP due to Sulawesi earthquake
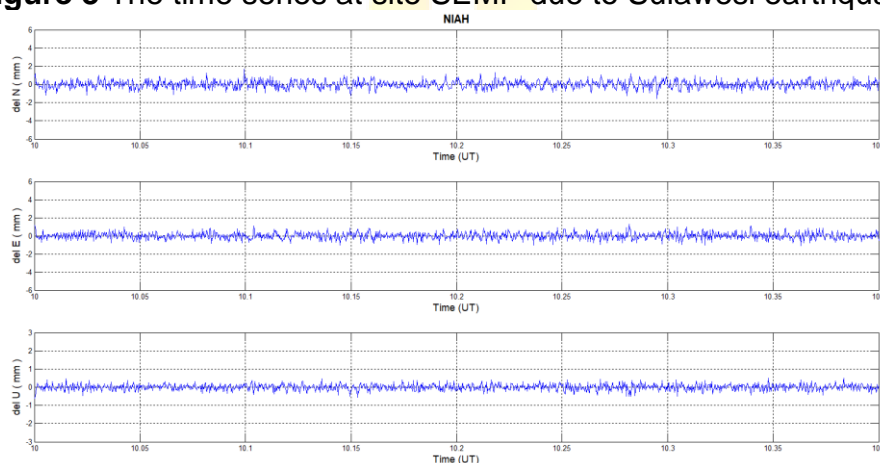
Figure 4 The time series at site NIAH due to Sulawesi earthquake
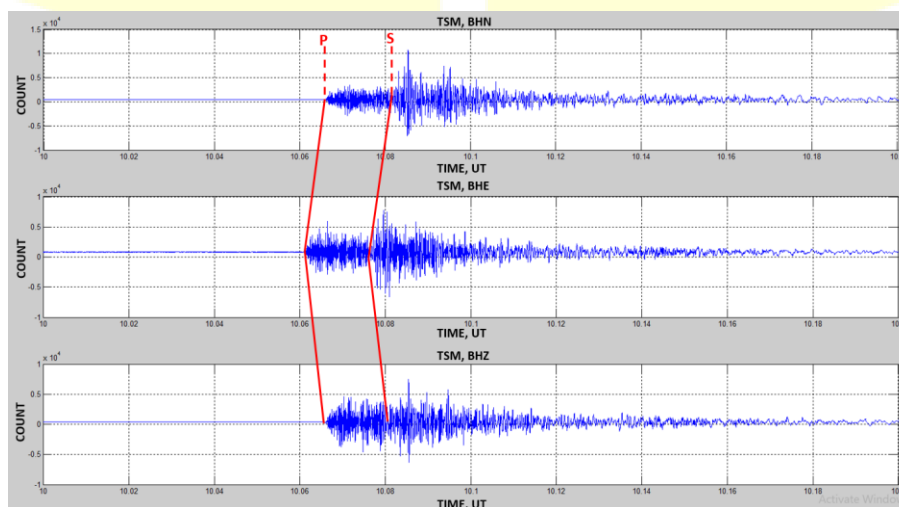
Figure 5 Picking TOA at site TSM
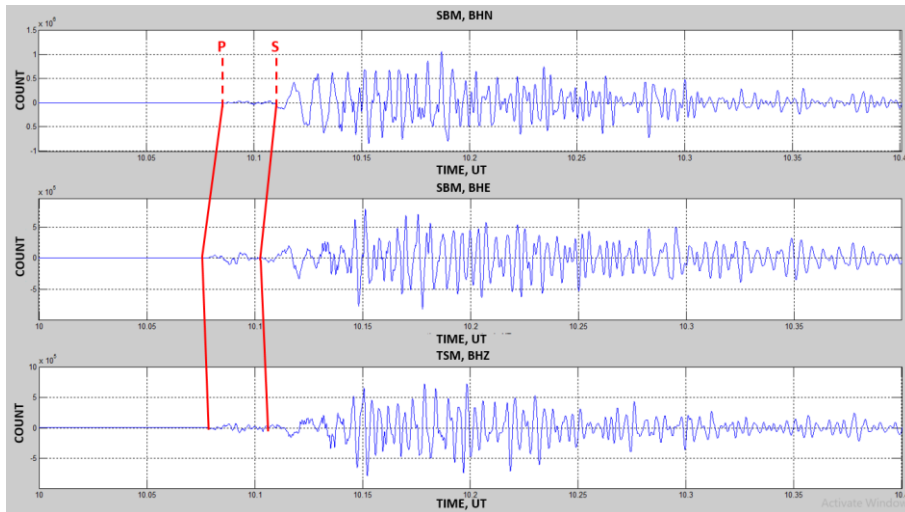
Figure 6 Picking TOA at site SBM

Performance of estimated PV

To validate the P and S-wave TOA, we can calculate the PV of this seismic wave speed whether it a body wave or surface wave. Table 1 show the estimation of PV for seismic body wave.

Table 1 Seismic body wave TOA and PV

Sensor	Epicenter, km	component	TOA P-wave, UT	TOA S-wave, UT	PV P-wave, km/s	PV S-wave, km/s
TSM	536.74	BHN	10.0658	10.0818	7.9862	4.1490
		BHE	10.0606	10.0767	11.4183	4.8994
		BHZ	10.0657	10.0809	8.0327	4.2642
SBM	893.20	BHN	10.0837	10.1100	6.9656	3.9868
		BHE	10.0782	10.1046	8.2555	4.3705
		BHZ	10.0785	10.1141	8.1729	3.7376

From Table 1, the result conclude that seismic body wave have successfully been captured during Sulawesi earthquake 2018, 7.5Mw. This result may be different from other study, the reason is different method were used in picking TOA and estimation of PV. The value checked with other finding on seismic body wave (P and S-wave) velocity range that varies from 1.5 km/s to 13 km/s and seismic surface wave (Rayleigh and Love wave) velocity between 2 km/s to 6 km/s (Selim Saleh, 1970; Cormier, 2015). It can be summarised that the estimated PV from this research is acceptable. Researcher with skill and experience in picking process will come out with better result (Massinai et. al., 2019).

CONCLUSION REMARKS

The event on 28 September 2018, seismic waves from the Sulawesi earthquake were analyzed. Far-field seismic waves were captured by the seismometer but not by the GPS, this problem occurs as per the criteria already stated. We suggest that institution that provide GPS CORS data should be advice to set the receiver to the high-rate (more than 1 Hz) observation. Moreover the installation of GPS CORS pillar should attach to the bed rock for better understanding on seismic wave. Furthermore, for better understanding on seismic wave signal from time series data, spectral analysis can be applied for better visualisation and interpretation of data. Further studies related to earthquake epicenters can be done using this parameter information. This research

method can also be used to study other earthquakes.

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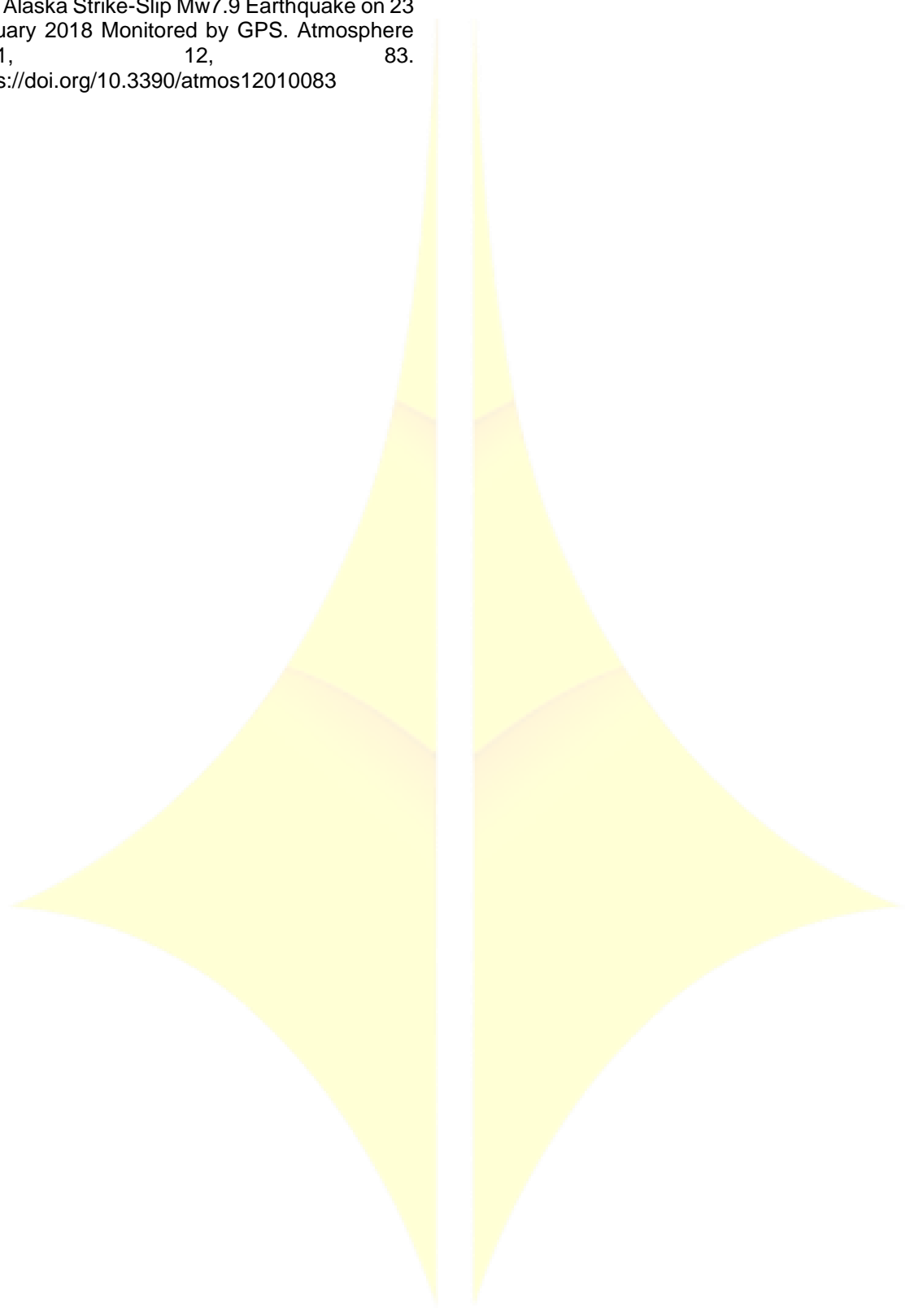
AN INSIGHT ON TECTONIC MOTION CHANGES IN MALAYSIA VIA GLOBAL POSITIONING SYSTEM (GPS) MEASUREMENTS

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ABSTRACT

Major earthquakes that occurred from 2004 until 2012 originating from the plate collision zone between the Sundaland, Australian and Indian plates triggered regional seismic instability. These significant seismic events caused inhomogeneous motion within the region over a while. However, the seismic status of the region in recent years is yet to be understood. This paper intends to discuss the tectonic motion changes in Malaysia that have been traced by GPS CORS in this region over two decades. In this study, crustal deformation trends derived from GPS measurements from two periods of time; before and after earthquakes were utilized to estimate tectonic motion changes. Between 2004 and 2012, GPS CORS measurements in Peninsular Malaysia indicated a significant tectonic displacement from 20mm up to 130mm, resulting from the impact of the earthquakes. Recent GPS CORS measurements from the year 2018 until 2019 have shown that Malaysia is in steady motion, with a rate of movement averaging 20mm per year. The findings of this paper shall provide an update on the crustal deformation occurrences in the region over time.

Keywords : Tectonic Geodesy, Crustal Deformation, Geodynamics

INTRODUCTION

Over the past decade, the Sundaland Block has been put into attention due to the occurrence of major earthquakes; 2004 Sumatra-Andaman (9.1Mw), 2005 Nias-Simuelue (8.6Mw), 2007 Bengkulu (7.9Mw) and 2012 Indian Ocean (8.6Mw). These significant seismic events had resulted in a substantial impact towards the seismicity of the region of which it had disturbed the surrounding plate and triggered instability of the Sundaland Block over time.

Several studies were done by researchers and authorities via geodetic approaches in quantifying the effects of these major earthquake events (Vigny et al., 2005; Kreemer et al., 2006; Konca et al., 2007; Borrero et al., 2009; Ambikapathy et al., 2010; Maulida et al., 2016; Aris, 2018). These studies have contributed to understanding the seismicity of the region during earthquakes occurrence specifically for Malaysia. However, in accounting continuous crustal deformation modelling process, the need of analyzing

GPS measurements from recent years observation is truly vital in understanding the current seismicity of this region. Therefore, this study aims to present the tectonic motion changes in Malaysia through analysis of GPS measurements from two period of time; during and after earthquake period.

DATA AND METHODOLOGY

In quantifying tectonic motion changes via GPS measurements, this study has been phased into three (3) stages. Figure 1 shows the framework implemented in this study.
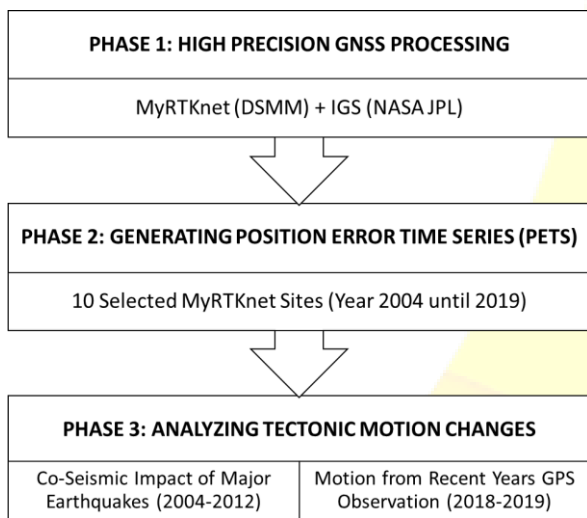
Figure 1 Designated framework of this study.

The first stage is data processing whereby GPS observation data spanning from December 2004 until December 2019 were processed using Bernese 5.2 high precision geodetic software in estimating GPS daily solution for selected Malaysia Real Time Kinematic GNSS Network (MyRTKnet) sites in Peninsular Malaysia. Second stage is the generation of GPS position error time series from the GPS daily solution whereas seismic cycle; inter, co and post-seismic were traced in the time series. Third stage will be the estimation of lateral displacement during and after seismic events whereby the tectonic motion changes over the years will be understood.

Phase 1: High Precision GPS

Processing

This study utilized continuous GPS observation data from 10 selected MyRTKnet sites in Peninsular Malaysia (see Figure 1) along with International GNSS Service (IGS) sites that are well distributed globally. Data from MyRTKnet network were provided by Department of Survey Mapping and Malaysia (DSMM) while IGS observation data along were obtained from the Jet Propulsion Lab (JPL) of the National Aeronautics and Space Administration (NASA) portal.
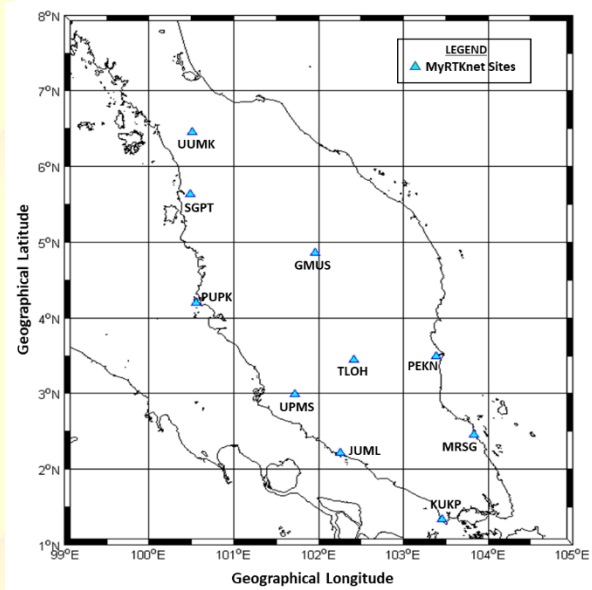
Figure 2 Selected MyRTKnet sites in Peninsular Malaysia.

In estimating daily solutions of the MyRTKnet sites, Bernese 5.2 high precision GPS processing software was utilized by implementing quasi-ionosphere free (QIF) strategy. Selected MyRTKnet sites were chosen and constrained to a number of IGS sites as fiducial sites in order to define International Terrestrial Reference Frame (ITRF) datum.

Phase 2: Generating Position Error Time Series (PETS)

After the estimation of daily solution, a GPS position error time series were generated. Multi daily solution in 3D Cartesian (X, Y, Z) coordinates were projected into local topocentric coordinates [(N,E,U], following the model

by Aris (2018) as follows:

$$y(t_i) = \begin{bmatrix} N(t_i) \\ E(t_i) \\ U(t_i) \end{bmatrix}$$

$$= \begin{bmatrix} \rho + h & 0 & 0 \\ 0 & (v + h)\cos \phi & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \Delta\phi(t_i) \\ \Delta\lambda(t_i) \\ \Delta h(t_i) \end{bmatrix}$$

where $\phi(t_i), \lambda(t_i), h(t_i) =$ geographical coordinates of point, $t_i =$ daily position epochs $(i = 2004.1, 2004.2, \dots)$ $\Delta =$ difference in radial magnitude of geographical coordinates and $\rho =$ radius of curvature in the meridian plane.

Phase 3: Analyzing Tectonic Motion Changes

In analyzing the tectonic changes via GPS measurements, position error time series is fitted with linear functional model (Montazeri, 2017) as follows:

$$y = at + b$$

Whereby a and b are the coefficients to be estimated; velocity and initial position while t is the corresponding epochs. Following this model, the site's velocity in the northward and eastward directions was calculated.

In accounting significant seismic cycle; permanent co-seismic impact of major earthquakes, analysis of position error time series will incorporate the co-seismic displacement equation following the approach of Niu et al., (2016) and Tiryakioglu et al., (2017) as follows:

$$\Delta_{\cos} = \sqrt{\left(e^D_{post} - e^D_{pre}\right)^2 + \left(n^D_{post} - n^D_{pre}\right)^2}$$

whereby $\Delta_{\cos} =$ permanent co-seismic displacement, $e^D_{pre}, n^D_{pre} =$ average horizontal positions before earthquake and $e^D_{post}, n^D_{post} =$ average horizontal positions after earthquake.

MAIN RESULTS

Several analyses were done in understanding the tectonic motion changes in Malaysia over time. Thus, this section will discuss on two primary outcomes of this study. The first section will discuss on the co-seismic impact of major earthquakes from year 2004 until year 2012 while the second section will discuss on the post-seismic decay period motion from recent years GPS observation.

Co-Seismic Impact of Major Earthquakes from Year 2004 until Year 2012

Analyses of GPS daily solution of selected MyRTKnet sites, has indicated co-seismic displacement during the occurrence of major earthquakes from year 2004 until year 2012. During the earthquakes impact, 10 sites of MyRTKnet in Peninsular Malaysia traced the impact and believed to be co-seismically deformed during the event (Aris, 2018). The co-seismic impact for each of the major earthquakes are tabulated in Table 1.

Changes within daily solution were then converted into horizontal vector as shown in Figure 2. From the vectors, it can be observed that the earthquakes had caused a widespread deformation with different orientation, respective to the location of earthquake epicenter.

Referring to Table 1 and Figure 3, Large co-seismic displacements of 2004 Sumatra-Andaman earthquake were traced at the northern region of Peninsular Malaysia whereby UUMK which is experienced significant displacement at 131.81 mm, moving westward towards the rupture zone. Reduction of displacement were observed from northern to southern region of which KUKP has the least co-seismic displacement traced at 16.67 mm.

Approximately four months following the 2004 Sumatra- Andaman earthquake, the 2005 Nias-Simuelue earthquake erupted and had also impacted the Peninsular Malaysia. The 2005 Nias-Simuelue earthquake similarly had caused a significant co-seismic impact whereby the low-slip rupture generated a widespread

deformation similar to the 2004 earthquake. Severely large horizontal displacement was traced at PUPK with 97.54 mm displacement towards south-west. Similar reduction trending of displacements was observed for sites ranging from the west coast region towards south whereby KUKP by traced co-seismic displacement of 12.39 mm.

Two years after the 2005 Nias-Simuelue earthquake, the 2007 Bengkulu earthquake erupted within the Mentawai segment, which as well impacted the Peninsular Malaysia. However, inhomogeneous co-seismic effects were traced by MyRTKnet sites during the earthquake occurrence. the earthquake eruption had caused a widespread afterslip, extended up to 1000 km radius from the nucleus epicentre in Mentawai (Aris, 2018). Inhomogeneous trending of co-seismic displacement and direction and magnitudes can be seen within Peninsular Malaysia whereby significant displacement mostly occurred in the southern region. large co-seismic displacements were depicted by KUKP at 25.84 mm. Different from 2004 and 2005 earthquake, the reduction trending becomes apparent from southern towards northern region of Peninsular Malaysia. Northern region of Peninsular Malaysia seems to depict smaller co-seismic displacement with UUMK displacing at 8.60 mm.

From the inhomogeneous motion, a clear spinning of co-seismic directions were detected sites in the north to the south-east region of the Peninsular Malaysia. This motion is due to two factors; the southern part of Peninsular is closer to the epicentre as compared to the northern part; and the crustal motion in the northern part were still induced by a great post-seismic arising from 2004 Sumatra-Andaman and 2005 Nias-Simeulue earthquakes that initially moved north-west direction (Aris, 2018).

Table 1 Co-Seismic impact of major earthquakes from year 2004 until 2012.

SITES	CO-SEISMIC IMPACT OF MAJOR EARTHQUAKES			
	2004 SUMATRA-ANDAMAN (mm)	2005 NIAS-SIMUELUE (mm)	2007 BENGKULU (mm)	2012 INDIAN OCEAN (mm)
UUMK	131.81	67.08	8.60	49.75
SGPT	126.09	73.31	8.18	60.59
GMUS	71.30	50.83	10.90	48.84
PUPK	90.83	97.54	12.88	60.04
TLOH	55.69	45.18	17.45	42.66
PEKN	36.48	28.17	15.64	37.36
UPMS	43.63	61.36	18.29	46.15
MERS	24.50	18.78	20.53	31.57
JUML	28.17	40.27	24.45	39.96
JHJY	17.82	11.08	26.82	29.63
KUKP	16.67	12.39	25.84	28.71
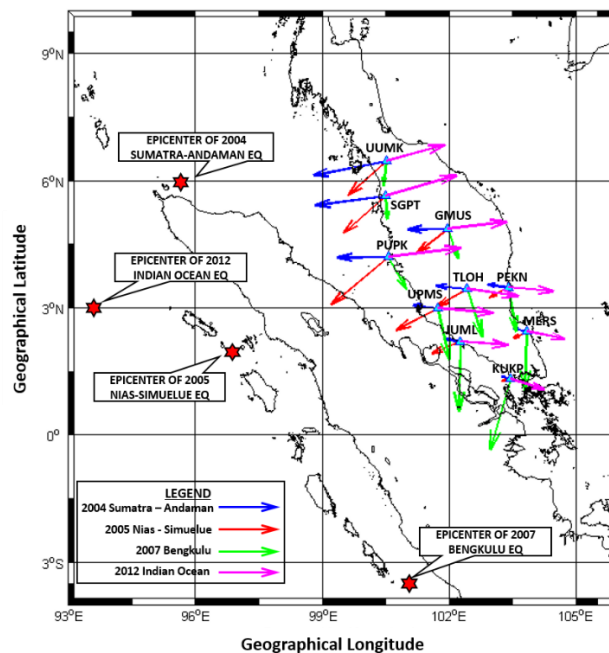
Figure 3 Co-seismic displacement vector of major earthquakes from year 2004 until 2012.

The last known major earthquake to erupted within the SSZ region is the 2012 Indian Ocean earthquake, erupted at the Wharton Basin area, 100 km west off the Sumatra subduction zone. Nonetheless, significant co- seismic displacements were traced up to 1100 km from the, thus indicating a widespread regional crustal deformation.

The impact of the earthquake towards Peninsular Malaysia had caused stations from northern to southern region to experience co-seismic displacement trending at north-eastward direction. Significantly large displacements were observed at stations within northern and west coast region with displacements ranging ~45 mm up to ~60 mm. In the northern region. UUMK displaced at 49.75 mm and similar reduction trend were observed towards southern region with KUKP experienced displacement of 28.71 mm

Tectonic Motion of Malaysia from Recent Year GPS Observation (Year 2018 and Year 2019

After the occurrence of last major earthquakes in 2012, Malaysia did not experience any significant seismic events. Nonetheless, the region experience post-seismic decay motion transitioning into inter-seismic period whereby the motion begins to stabilize by following the Sunda Plate motion. Therefore, daily solution from recent years observation; year 2018 and 2019 from 10 selected MyRTKnet sites were analyzed. Table 2 shows the motion of Malaysia via site velocity estimation of the selected MyRTKnet sites.

Site velocity estimation of MyRTKnet sites in Peninsular Malaysia has shown that Malaysia is in steady motion from northern to southern region, with average motion estimated at 20 mm/year. The motion is apparent in Easting component, indicating that the region is following the rotation of Sunda Plate. Figure 4 shows the depiction velocity vector of selected MyRTKnet sites that has been estimated via two years of daily solution. Figure 5 shows Position Error Time Series (PETS) generated for two (2) MyRTKnet sites; UUMK and KUKP for year 2018 and 2019 respectively.

Table 2 Motion of Malaysia via site velocity estimation.

STATIONS	SITE VELOCITY ESTIMATION (JANUARY 2018 - DECEMBER 2019)		
	NORTHING (mm/year)	EASTING (mm/year)	UP (mm/year)
UUMK	-7.07	18.78	7.09
SGPT	-7.86	21.19	5.24
GMUS	-6.96	25.01	5.25
PUPK	-6.25	22.39	5.57
TLOH	-6.99	24.55	5.11
PEKN	-6.22	25.86	6.30
UPMS	-5.62	24.56	4.95
MRSG	-7.36	26.15	4.85
JUML	-7.05	25.86	3.35
KUKP	-6.18	25.06	14.14

*note that station MERS has been renamed onto MRSG by DSMM.
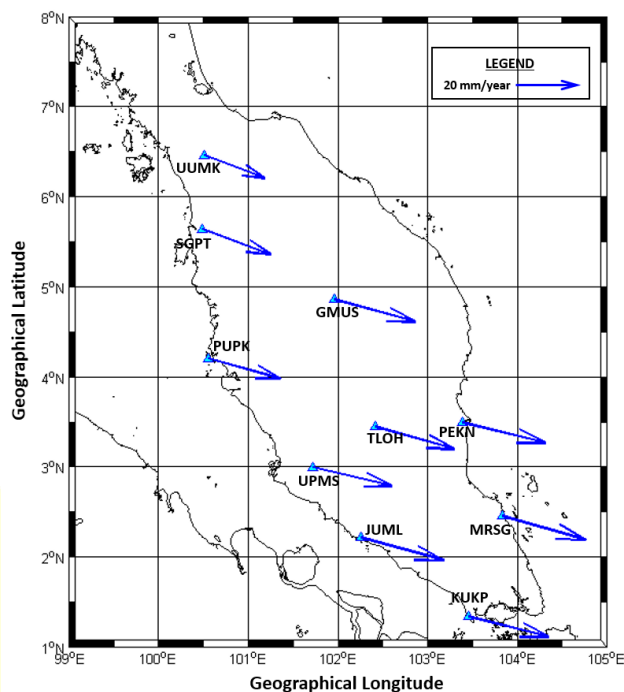
Figure 4 Velocity vector of MyRTKnet sites in Peninsular Malaysia.
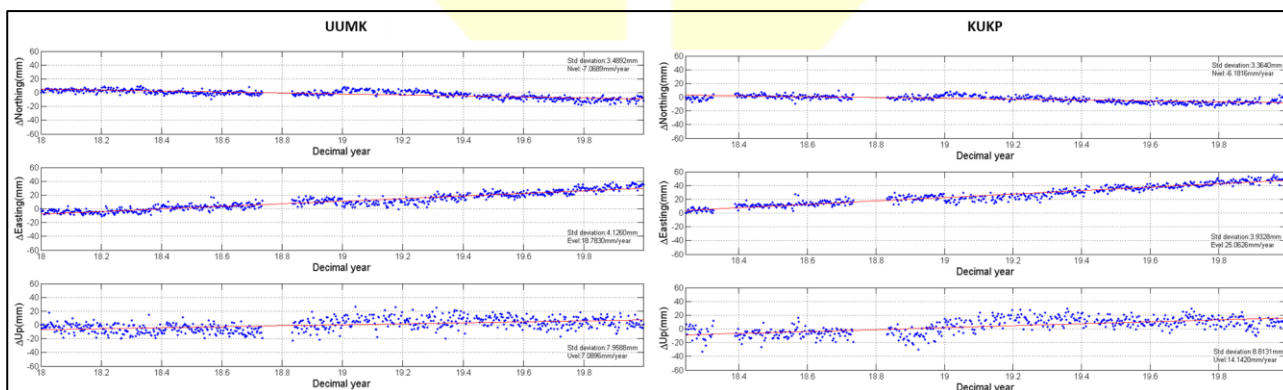
Figure 5 Position Error Time Series for two (2) MyRTKnet sites; UUMK and KUKP for year 2018 and 2019.

CONCLUSION

Analysis of GPS observation from two periods of time; before and after earthquakes at selected MyRTKnet sites in Peninsular Malaysia has shown that Malaysia has experienced significant tectonic changes over the decade.

Co-seismic impact traced by MyRTKnet sites within year 2004 until year 2012 has shown the major earthquakes had caused a significant motion shift in the region whereby displacement ranging from 20 mm up to 130 mm were traced.

However, after the occurence of last major earthquake namely the 2012 Indian Ocean earthquake, Malaysia did not experience significant seismic events therefore experiencing post-seismic decay period and transitioning into inter-seismic period. Recent years GPS observation; year 2018 and 2019 has shown that Malaysia is moving steadily at the average rate of 20 mm/year.

The outcomes of this study shall provide understanding the tectonic motion changes in Malaysia traced via GPS measurements. This study will also contribute in development of regional crustal deformation model which will be beneficial for seismic hazard mitigation and geodetic infrastructure maintenance.

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OVERVIEW OF INTERNATIONAL CORS SETUP AND OPERATIONAL PRACTICES

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ABSTRACT

Global Navigation Satellite Systems (GNSS) is a type of space technology that has emerged as an essential component of positioning, navigation, and timing (PNT) across an extensive range of applications, both military and commercial. Continuously Operating Reference Station (CORS) networks are a typical type of GNSS ground-based augmentation infrastructure that used to deliver centimetre accurate PNT information throughout a nation or region. In several countries, the operational model of CORS networks was different, ranging from government organisations performing all the roles, to a mixture of government and private sector, or to massive private networks. This paper provides an overview of the international CORS setup and operational models in order to optimise the data usage among the users and to maintain operational viability. The paper discussed requirements to create a clear conceptual framework for CORS operational in the country.

Keywords : GNSS, CORS, PNT, conceptual framework

INTRODUCTION

Global Navigation Satellite Systems (GNSS) has become an essential component in modern times for positioning, navigation, and timing (PNT). This space technology has a wide range of applications, including land and marine transportation, aviation, tracking, geo-engineering works, earth monitoring, and many more. The growing reliance on GNSS is acknowledged on a global scale, and some countries are even developing their own global navigation systems. These include the Global Positioning System (GPS), which is operated by the United States of America; the Russian Globalnaya Navigazionnaya Sputnikovaya Sistema (GLONASS); China's BeiDou Navigation Satellite System (BDS); and the Galileo Satellite Navigation System (GALILEO), which is operated by the European Union. The GNSS industry started making investments in the creation of new systems and applications, particularly mobile apps, in recent years. There are now billions of PNT units

operating all over the world, and new hardware and software designs smaller, cheaper, and more capable to serve a wider range of user markets.

In addition, a satellite-based augmentation systems are also being developed to support precise point positioning and real time applications. This system uses geostationary satellites to broadcast primary GNSS data that have been enhanced by integrity and correction information provided by a network of ground stations covering large areas, and thereby improves precision and reduces position errors to less than 1 meter accuracy.

The Continuously Operating Reference Station (CORS) networks are a common form of ground station that governments and industry use to distribute centimeter accurate PNT information across the region. CORS networks have been deployed locally, nationally and globally to meet the scientific and commercial demands from multiple sectors.

In general, CORS infrastructure consisted essentially of four components: an observation station, data transmission, a central facility, and data distribution (Strange, 1995). Every CORS network is made up of a number of GNSS observation stations that are linked together by reliable communications to allow for real-time computations and control. Each station requires a geodetic receiver, an antenna attached to a stable monument, and ability to receive GNSS satellite signals continuously 24 hours a day. In some instances, an additional computer is installed for data transmission and control, but modern receivers with the appropriate communications and network management able to stream raw data back to a central facility.

Currently, CORS infrastructure serves a large number of professional GNSS surveying, geodetic, mapping, and navigation users. The widespread use of techniques are support non-geodetic and high-precision positioning applications in engineering, machine guidance, precision agriculture, advanced intelligent Transport Systems, and etc (Rizos et.al, 2010).

The operational models of the CORS network differed across countries, ranging from government organizations playing all roles, to a mixture of government and private sector or to large private networks.

This paper provides an overview of the international CORS setup and operational models in order to optimise data utilisation among users and maintain operational viability. Furthermore, it discussed the requirements for creating a clear conceptual framework for CORS operational in the country, in order for policymakers to be involved in forming new arrangements for long-term sustainability development of CORS infrastructure.

OVERVIEW OF INTERNATIONAL CORS SETUP AND OPERATIONAL PRACTICE

Most countries have developed almost a similar way when it comes to establishing CORS infrastructure to enable the use of data for civil, scientific, and commercial purposes. CORS are operate differently based on a variety of models and practices. Several countries were selected for this study.

i. United States and Canada

In United States, the CORS infrastructure mainly is funded independently though public or private investment. The National Geodetic Survey (NGS), within the National Oceanic and Atmospheric Administration (NOAA), is in charge of the national CORS network and other infrastructures. The role of NGS mainly to provide the geodetic framework for all national positioning activities. Currently, this

agency manages access to nearly 1887 multi-purpose CORS stations located throughout the country that are cooperatively contributed by 239 government, academic and private partners (Harold, 2022). The NGS invites organisations and individuals to contribute to the national CORS network by sharing data from their permanent station, provided they adhere to NGS-published CORS guidelines. NGS analyses and monitors the data it receives and makes it freely available to the public for post-processing purposes (NGS, 2013).

In North America, industry service providers have begun to network positioning services. For example, SmartNet North America uses a licencing model to connect approximately 600 CORS site located throughout the region, using data licenced from government and privately owned CORS. Apart from that, Trimble has adopted a similar licensing model to SmartNet through it VRS Now service (Trimble, 2013a). The data-licensing model enables multiple service providers to access the same CORS infrastructure that improves the consistency of their computed PNT information. From an economic perspective, coordinating access to a single CORS single station is more cost effective for any operator than installing multiple CORS in the same location. User also can take advantage of a more stable and dense network.

ii. Canada

In Canada, each province oversees the technical, institutional, and economic arrangements for deploying and managing the CORS infrastructure independently. The Geodetic Survey Division (GSD) of Natural Resources Canada (NRCan) is responsible for managing the Canadian Spatial Reference System in collaboration with Geological Survey Canada (GSC). The industry service providers have been more proactive in CORS stations

development to provide high-precision locating services within certain provinces. Most are them are make GNSS observations from their CORS stations available to NRCan to integrate their coordinates into the national standard.

Can-Net, the industry's leading service provider, is a privately owned network with over 300 CORS stations throughout the country that support thousands of active users in the agriculture, geospatial, and construction markets (Can-Net, 2021). Apart from that, Leica SmartNet, Trimble Can-Net, Topcon TopNET, Lewis Instruments and BrandtNet also among the industry service providers in the region.

iii. United Kingdom

In United Kingdom, the National Mapping Authority or Ordnance Survey is responsible for the CORS network known as OS Net. This agency is responsible for creating, maintaining, and disseminating geospatial data as well as managing the national geospatial reference system. Apart from managing over 100 CORS infrastructures for OS Net services, Ordnance Survey collaborates with commercial service providers to deliver positioning services, including Leica Geosystems' SmartNet (UK and Ireland), Trimble's VRS Now, Topcon Positioning System's TopNetPlus, AXIO-FarmRTK, NET's and Soil Essentials' Essentials Net (Ordnance Survey, 2013).

In addition, the Ordnance Survey acts as a data custodian, licencing access to OS Net's raw data streams for processing and distribution by commercial service providers. In exchange for licensing access to its raw data streams, OS Net collaborated with a service provider to gain access to correction data for monitoring the national geospatial reference system. The OS Net also makes its online RINEX archive available for public use and sharing.

iv. Australia

Australia was an early adopter of GNSS solutions. Over the last three decades, the country has setup ground infrastructure and operate high positioning service to support a wide range of sectors and industries. This has resulted in a growing number of economically significant sectors and the emergence of new industries and opportunities in areas such as location-based services and intelligent transportation systems (Rizos et al., 2012).

Several initiatives have been taken in this regard to oversee the national GNSS infrastructure development as well as to support the acquisition, processing, distribution and extending user access of multi-GNSS data. Among them are the Spatial Information Council's (ANZLIC) implementation of the National Positioning Infrastructure Policy, the Australian Spatial Consortium's (ASC) Strategic Plan for GNSS, and Geoscience Australia's National Infrastructure Plan (NPI). The NPI will improve and enhance the existing CORS infrastructure, governance and data sharing arrangements (Queensland Foundation Spatial Data Framework, 2018).

Geoscience Australia cooperatively operates and maintains GNSS networks of approximately 100 CORS across the country and the South Pacific, including: Australian Regional GNSS Network (ARGN); South Pacific Regional GNSS Network (SPRGN); and AuScope Network. Unique to Australia is the federal, state and territory governments are responsible for funding and managing ground infrastructure such as CORS network as part of their positioning infrastructure. Each jurisdiction has a significant degree of autonomy in developing spatial policies that articulate roles and responsibilities for deploying, accessing and managing

CORS infrastructure and broader positioning frameworks (Hale, 2007). As a result, the CORS infrastructure investment by State and Territory governments has been found to be inconsistent and primarily influenced by regional commercial incentives.

v. Japan

In Japan, the Geospatial Information Authority (GSI) is responsible for the establishment of the CORS network known as GEONET. The network currently operate 1308 stations and is used to monitor crustal deformations, tsunami warning as well as for precise surveying and geodetic frame (Basara, 2016). GSI provides free access to GEONET data, and selected sites are equipped with resources to enable single-based RTK service (Grant, 2014). The government of Japan intended to promote precise positioning services, and the CORS network could be operated in an integrated manner with ASEAN country, with the correction data made available to the private sector. In this regards, the Act on the Advancement of Utilizing Geospatial Information (AUGI): 3rd Basic Plan was introduced on March 2017 with the goal of fostering the development of new industries and services through the high accurate and value-added geospatial information data (Katsuhiro, 2017). The country believes that this is in line with technological innovations such as IoT, big data and artificial intelligence.

vi. Thailand

In Thailand, over twenty organisations are engaged in geospatial data and mapping-related activities. At least nine organisations, including three universities are involved in the establishment of GNSS CORS ground infrastructures for their respective purposes. It plans to install more than 200 CORS over the country (Chalermchon, 2019). Thus, it may be difficult to integrate CORS data and services into a single organisational system in order to optimise the benefits to the government and

the public, as well as to increase the value for investments in the ground infrastructure.

Additionally, the Thai government is strengthening its positioning infrastructure known as National CORS Data Centre (NCDC) in order to support the Thailand 4.0 initiative. The National Geospatial Information Committee (NCGI) was established to manage the country's geospatial infrastructure and data. This committee chaired by the Prime Minister, was tasked with imposing geospatial data, remote sensing standards, and services in order to reduce duplication, improve data sharing, and integrate the information that would be exchanged. Besides that, the government finalised a single-window policy for international cooperation on the CORS network's use in the country, with the Royal Thai Survey Department coordinating international cooperation among operating agencies (Shibasaki et al., 2018).
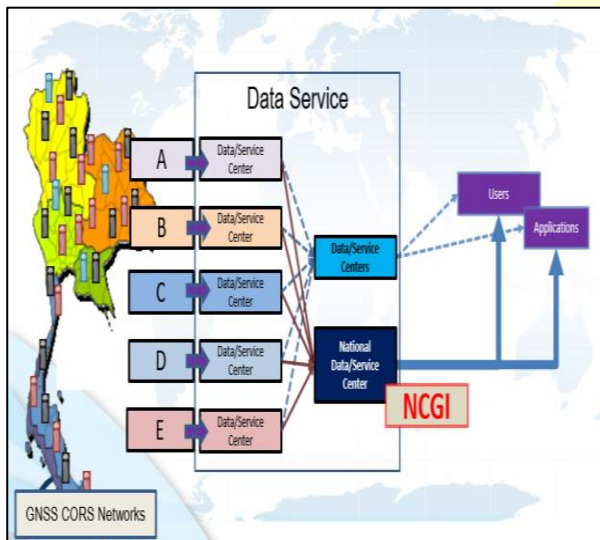
Figure 1 Concept of GNSS CORS Data Services (Tatiya, 2016)

The Geo-informatics and Space Technology Development Agency (GISTDA) is drafting a roadmap for GNSS CORS Data services administration and management (Figure 1). The roadmap covered a number of activities, which consist of the establishment of a clearly-directed policy on GNSS CORS Data Center and framework for data sharing and services, and providing CORS standards for installations and operational in order to enable interoperating between all stakeholders for more effective and efficiently. The document also discussed the promotion of the use of CORS data for driving economic by making the CORS data accessible and available to all sectors and users for application development (Tatiya et al., 2018).

CORS INFRASTRUCTURE IN MALAYSIA AND KEY ISSUES

Several CORS networks are currently operational in Malaysia and managed by various government agencies, universities, and industry. Among that, including the Department of Survey and Mapping Malaysia (JUPEM), which operates the MyRTKnet network with 97 CORS stations primarily for the surveying profession. All data has been recorded and transmitted every second to the Control Center at JUPEM headquarters as well as the Public Sector Data Center in Putrajaya. Local users able to subscribe to multiple services, such as real time and post processing services, virtual rinex post-processing, and GPS Reference Station post-processing (MyRTKnet, 2021).

Other CORS infrastructure include Sistem Pelayaran Satelit (SISPELSAT), National R&D CORS (NRC-net) and Geosentric Network (SGeDNet). SISPELSAT and NRC-net data are provided free of charge to users for marine navigation and research and development, respectively. Numerous local users are utilising the data to improve the accuracy of their work pertaining to surveying, mapping, and navigation.

Although within the nation, integrating all the CORS stations was difficult since the CORS operating came from variety of organizations. The data observation is not centralized to provide standard services. It might led an indirect impact on the opportunity to develop new GNSS downstream applications particularly that involving real-time data. Furthermore, there are only a few documented policies and acts related to GNSS and CORS in place.

Therefore, establishing a clear institutional structure or an efficient coordination mechanism could be one aspect of coordinating CORS-related agencies across all sectors, from infrastructure setup to the management of data, dissemination and standardisation.

CONCEPTUAL FRAMEWORK OF CORS

The CORS infrastucture in Malaysia is at a very developed stage. The government has assumed nearly all responsibilities for establishing, operating and providing CORS network service. These infrastructure continue to be maintained and invested by the government. In contrast to the majority of developed countries, such as the United States' National Geodetic Survey and National Oceanic and Atmospheric Administration (NGS NOAA), the responsible organisations did provide data access to industry so that it could market its own value-added positioning services to the general public.

The lack of a standard framework resulted in the absence of a sustainable budget for the national programme. The conceptual framework is necessary as a first step before developing the various specific models. Each organization's role in operating CORS need to be clearly defined in order to avoid authority conflicts and put in place an effective coordination mechanism. In this regards, Higgins (2008) was identified model for understanding organizational roles in managing the CORS network to delivery of precise positioning services.

CONCLUSION

GNSS or CORS data provide a wide range of benefits. The data should be shared and made accessible with minimum restrictions in order to realize and optimize these benefits.

To fully utilise CORS data and country's benefit, it is a necessary to have a conceptual framework on GNSS infrastructure and data. In addition, GNSS is now contributing to Big Data by combining PNT information with other technologies, and it can be considered as fundamental element of Industry 4.0 due to its ability to improve current technological advancements. Without the framework, it is difficult to optimise the benefits of GNSS and it may result in lack of continuous government support to the programme and development.

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A SPATIAL ANALYSIS OF THE RELATIONSHIP BETWEEN THE SOCIOECONOMIC VARIABLES AND HOUSEHOLD CHARACTERISTICS TOWARD FLOOD EVACUATION DECISION

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ABSTRACT

Climate change poses a significant threat, increasing the frequency and severity of natural disasters such as floods, hurricanes, cyclones, and droughts. Among these disasters, flooding stands out as the most destructive, widespread, and prevalent. To minimize the impact of flood disasters, it is crucial to implement preparedness measures, particularly flood evacuation strategies. A key factor in reducing potential loss of life during floods is understanding human behaviour, particularly in response to evacuation warnings. Consequently, research has been conducted to identify and categorize the variables influencing human decision-making in the face of flood disasters and the evacuation process. These variables include household characteristics, physical building attributes, and socioeconomic variables. The study findings reveal that previous flood experiences significantly influence households' decision-making during flood evacuation. This insight can inform the development of effective emergency evacuation plans and improved Integrated Flood Management (IFM) systems by the government and related agencies.

Keywords: Flood Evacuation, Human Decision-Making, Integrated Flood Management

INTRODUCTION

Generally, floods are one of the most destructive natural disasters that result in large losses of life and property. The Rentschler et al. (2022) study finds nearly a quarter of the world's population, or 1.81 billion people, live in flood-prone areas with flood inundation depths greater than 0.15 m every 100 years. Almost millions of people have been affected by flooding, particularly in Thailand, Bangladesh, Indonesia, Philippines, Myanmar, and Malaysia (Venkatappa et al., 2021).

In order to minimize these losses and expedite the recovery process, adequate preparedness and disaster management planning are essential. Therefore, shifting from the traditional flood protection paradigm to better Integrated Flood Management (IFM) to prevent, manage and coexist with flood risks is essential. Various hydrological researchers have

implemented IFM, such as providing convincing flood risk assessment and management to minimize global flood risk (Albano et al., 2017; Hassan et al., 2020; Klijn et al., 2015; Morrison et al., 2018; Vercruysse et al., 2019).

However, the interactions between individuals and organizations, the extent of flood events, and feedback or decision-making by affected communities all affect the effectiveness of IFM in flood evacuation management. In general, flood evacuation is a crucial preparedness measure that can help minimize casualties and relocate people from areas of high flood risk to areas of safety. Nevertheless, flood evacuation is a complex, dynamic process, and human-environment interactions that can cause additional hazards. Therefore, the variables that influence human decision-making or behaviour toward flood evacuation were identified and implemented.

MAIN RESULTS

In flood evacuation planning and operations, input from relevant decision makers such as households and authorities (evacuation managers and traffic planners) are necessary. Evacuation decisions involve complex behavioral variables affecting various characteristics and situations of households during the selection period. Thus, variables influencing human decision-making during flood events and the evacuation process were determined, such as physical building attributes, household characteristics, and socioeconomic variables.

This study was conducted on the flood events that occurred in Pasir Mas region, which it was recorded as the most affected area by flood events in late 2021 and early 2022. Basically, this study focuses on determining the socio-economic and household characteristics variables that influence human decision-making during flood events, especially during the flood evacuation phase in the Pasir Mas area. The questionnaire survey results was analyzed to explore the residents' perceptions and attitudes toward the flood evacuation process.

Generally, the human evacuation decisions were affected by the household's physical characteristics, such as the type of building, building materials, age of the dwelling, and ownership of the building. The results show that most of the evacuated households were willing to evacuate when their houses were traditional and terrace houses compared to other building types. Figure 1 shows the distribution of the building types in the research area. Besides that, the type of construction material, such as soil, cement, or wood, can affect evacuation decisions during a flood, as well as a home's safety.
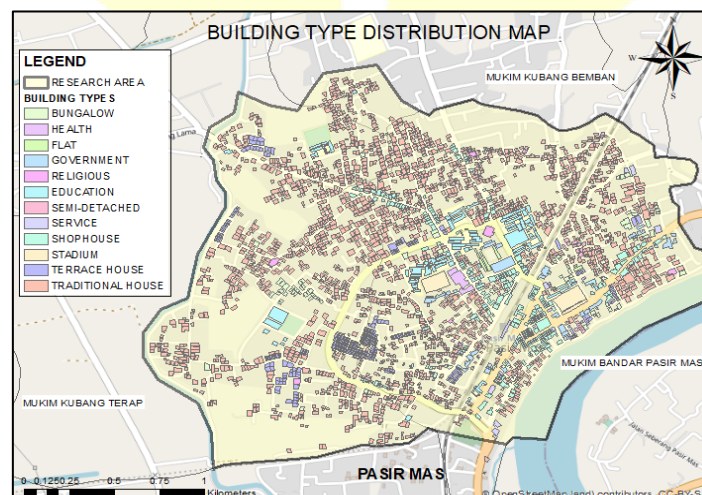
Figure 1 Building Type Distribution Map

In addition, household characteristics such as age group, family size, mobility, or health status of residents can also affect human decision-making during flood evacuation. In general, families with elderly people, large families, and health problems will often refuse or find it difficult to evacuate when there is a flood disaster due to difficulties in relocation or inconvenient movement.

Furthermore, residents' previous flood experiences play a major role in their decision-making during the flood evacuation process. Generally, people with extensive flood experience will be more vigilant about flood damage, water levels, and hazards when floods begin. However, the abundance of experience has also resulted in an underestimation of flood risks, as well as erroneous decisions, especially when past events have been less severe.

The socioeconomic variables such as flood awareness and preparedness, weather warning and forecasting systems, social media systems, financial and insurance support assistance, and local government responsibilities also influenced residents' cogitation when making evacuation decisions. for instance, social media as a communication tool has been influencing decision-making or household behaviour, especially during flood preparedness and evacuation phases. For example, flood victims in Kelantan sought help through social media such as Instagram, Twitter and Facebook in addition to getting the latest information on flood incidents.

CONCLUSION

Floods are one of the most destructive natural disasters, causing huge loss of life and property. To minimize these losses and expedite the recovery process, adequate preparedness and disaster management planning are critical. Thus, evacuation decisions are very important inputs for evacuation planning and modelling. Therefore, identifying and analyzing the complex socioeconomic and household indicators that influence flood evacuation decisions is critical for better planning and evacuation actions.

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MONITORING GROUNDWATER STORAGE USING GRAVITY RECOVERY AND CLIMATE EXPERIMENT (GRACE) SATELLITE AND HYDROLOGICAL DATA IN KELANTAN, MALAYSIA

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ABSTRACT

Kelantan is a state that uses underground water as a daily requirement since 1935. There is 70% of the total domestic water supply in Kelantan is from underground water. Therefore, this study is to identify changes in groundwater in the Kota Bahru and Pasir Mas areas by using the Gravity Recovery and Climate Experiment (GRACE) and hydrological data measurements. The GRACE gravity data from 2003 until 2021 are used to determine the terrestrial water storage (TWS) changes in the study area. GRACE provides temporal variations of TWS consisting of soil moisture, surface water and groundwater. To calculate groundwater storage (GW), ancillary datasets of soil moisture and surface water from Global Land Deformation and Analysis System (GLDAS) are required. Furthermore, hydrological data from rainfall and equivalent water height are used in this study to analyse the groundwater storage. The groundwater storage values highest and lowest for the years 2006 and 2005 were recorded as 91.1434 cm and 66.3667 cm, respectively. The results of this study show that there is a relationship between seasonal changes in groundwater storage, hydrological data and the excessive use of groundwater by humans, which are the causes of groundwater depletion.

Keywords : Gravity Recovery and Climate Experiment (GRACE), groundwater storage, hydrology data

1.0 INTRODUCTION

The exploitation of underground water sources has been known to harm ecosystems and the environment in Malaysia. The negative impact is that it will lead to land subsidence, the occurrence of intrusion of seawater into groundwater or surface water sources as well as a decrease in the water level or rate of inflow. Underground water extraction is widespread also reducing the base of rivers and lakes leading to the disappearance of the natural resources of Malaysia's water catchment area. Even Malaysia's agricultural landscape crops will also be affected due to sudden changes in the water supply system of underground natural (Waqas et al., 2017). In Malaysia, the area that uses a lot of underground water as the alternative

water sources is in Kelantan since 1935 (Ismail, 2009). There are more than 30 of wells were built in Kelantan involving area of Kota Bharu, Pasir Tumboh and Pasir Mas. Tube wells are being implemented in regions within the state that are currently facing a severe shortage of potable water. Tube wells is the same as the facilities of usual well, but it is just uses a special pipe to suck up the underground water (aquifers). This study is to identify changes in groundwater in the Kota Bahru, Pasir Tumboh and Pasir Mas areas by using the Gravity Recovery and Climate Experiment (GRACE) and hydrological data measurements.

The overutilization of unprocessed water resources has been widely recognized for its detrimental impacts on ecosystems and the environment in Malaysia. One potential adverse consequence is the occurrence of land subsidence, which can be attributed to the extraction of groundwater. Additionally, groundwater salinity may rise, accompanied by an increase in seawater intrusion into the groundwater system (Wada et al., 2010). Furthermore, a decline in the water level or the inflow rate may also be observed. Additionally, it is worth noting that the depletion of the riverbed and lakes in Malaysia will inevitably lead to the gradual disappearance of the natural resources within the watershed.

GRACE, which stands for "Gravity Recovery and Climate Experiment," was a satellite mission that began operations in 2002 with the purpose of measuring the gravity field of Earth and how it has changed over time. It was able to provide valuable information about changes in the mass distribution of the Earth, such as changes in water storage, the melting of ice, and the motion of land (Famiglietti et al., 2011; Wahr et al., 2006). GRACE's primary mission was to monitor changes in the water cycle of the planet, which included activities such as tracing the flow of water between the Earth's oceans, atmosphere, and land. Although it was not intended to directly measure the vertical motion of the land, it did inadvertently provide information about this phenomenon (Tapley et al, 2004).

GRACE data was used to estimate the vertical motion of the land by looking at changes in the Earth's gravity field caused by things like tectonic movements, post-glacial rebound, and subsidence caused by pumping groundwater or natural compaction (Famiglietti et al., 2011). The GRACE mission offers a novel opportunity for the monitoring of changes in large-scale ground water storage (GWS). Temporal fluctuations in the gravity field over terrestrial regions primarily arise from alterations in terrestrial water storage (TWS). TWS encompasses the cumulative effects of groundwater, soil moisture (SM), reservoir storage, and surface water (SW).

The interaction between groundwater and surface water is a fundamental aspect of hydrological systems, as these two components are intricately linked. In areas characterised by a shallow water table, alterations in soil moisture levels can impact the exchange of water between subsurface groundwater and surface water systems. In periods of reduced precipitation, characterised by low soil moisture levels, there is a possibility of a decline in the groundwater table. This decline has the potential to affect the accessibility of water for streams, wetlands, and ecosystems that rely on groundwater contributions (Li et al., 2019).

The Gravity Recovery and Climate Experiment (GRACE) satellite mission has been employed to observe groundwater storage (GWS) variations in regions of significant depletion worldwide. Specifically, GRACE has been utilised to monitor GWS changes in significant regions such as north western India, as studied by (Long et al., 2016), and the U.S. High Plains, as investigated by (Famiglietti et al., 2011) and (Tiwari et al, 2009). Furthermore, the GRACE has been utilised to evaluate variations in groundwater storage (GWS) in the California Central Valley, as investigated by (Strassberg et al., 2009) and (Scanlon et al, 2012).

1.1 Total water storage (TWS)

Total Water Storage (TWS) is defined as the total amount of water contained in several reservoirs located within a certain geographical region. This contains the water that is stored inside surface water bodies, such as lakes, rivers, and reservoirs, as well as the water that is held within subsurface aquifers (Henry et.al., 2011). The measurement of TWS is commonly conducted by a variety of methodologies, involving satellite-based remote sensing, ground-based observations, and hydrological models. Remote sensing techniques, represented by the GRACE satellites, have shown to be highly advantageous in the acquisition of comprehensive global terrestrial water storage information (Strassberg et al., 2009).

1.2 Global Land Data Assimilation System (GLDAS)

The acronym GLDAS refers to the Global Land Data Assimilation System. The project in question is an initiative by NASA, the National Aeronautics and Space Administration, which aims to combine data from satellites and ground-based observations in order to create models and monitor the cycles of water, energy, and carbon on Earth's surface (Rodell et al., 2004). The primary objective of the GLDAS is to supply comprehensive and consistent data pertaining to the conditions and processes occurring on the Earth's land surface (Mccullough, 2013; Syed et al., 2008; Yeh et al., 2006). After collecting this information, it is used to make soil moisture maps, temperature maps, snow cover maps, evapotranspiration maps, and surface water map (Luo et al., 2016).

2.0 MATERIALS AND METHODS

2.1 Study Area
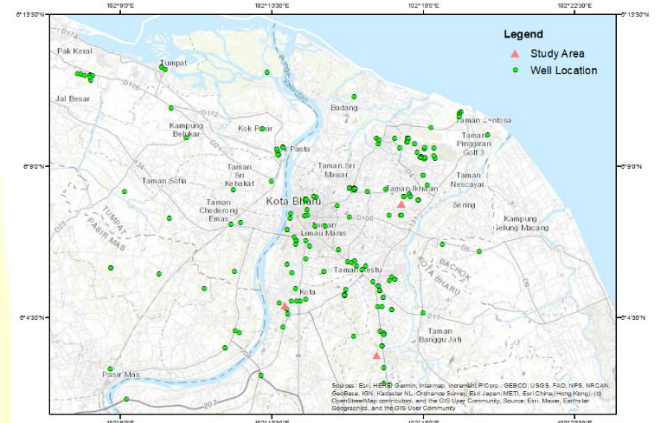
Figure 1 The study area involves the regions of Kota Bharu and Pasir Mas

The study area is in Kota Bharu and Pasir Mas, Kelantan. It is situated in the coordinate 102° 13' E longitude, 6° 04' N latitude and 102° 17' E longitude, 6° 08' N latitude. This study area is located near a tube well that is registered with Department of Mineral and Geoscience Malaysia. The location of the study area in triangle-marked and the circle green-marked tube wells are shown in Figure 1. The selection of this study area was based on its extensive use of groundwater compared to other regions.

2.2 Data and Methods

The study utilised the following datasets: (a) Total water storage (TWS) data from the period between 2003 and 2021 is obtained from GLDAS Catchment Land Surface Model (CLSM) level 4 data measured in centimetres on a daily basis with a spatial resolution of 0.25 x 0.25-degree equivalent to 27 to 28 kilometre (https://disc.gsfc.nasa.gov/datasets?keyw ords=soil%20moisture&page=1&subject= Ground%20Water&project=GLDAS), (b) soil moisture and surface water data from GLDAS NOAH land surface model (LSM), measured in kilogrammes per square metre on a monthly basis with a spatial resolution of 0.25 degrees (Beaudoing and Rodell, 2020), and (c) In-situ rainfall data for the period 2008 until 2018 obtained

from the Department of Irrigation and Drainage (JPS).

In order to determine groundwater storage (GW), it is necessary to utilise auxiliary datasets such as total water storage, soil moisture data and surface water storage obtained from the GLDAS. Figure 2 shows the illustrates the methodology that was used to conduct the study. The information obtained by EWHs is not a precise gauge of water volume or depth. Instead, it may be used to evaluate the impact of changes in the groundwater storage distribution and water masses on the ecosystem. In-situ monitoring data on rainfall is essential for predicting and managing groundwater recharge. The equation to calculate groundwater storage is:

$$GW = TWS - (SM + SW) \qquad (1)$$
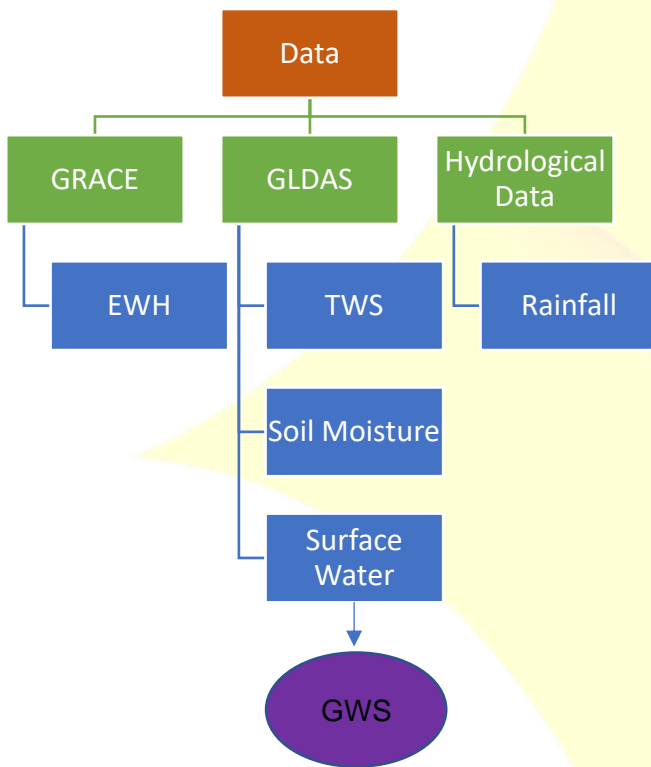
Figure 2 The methodology chart of the study.

3.0 RESULTS AND DISCUSSION

3.1 Annual Rainfall

The average annual rainfall in Pasir Mas is plotted in Figure 3 for the years 2009 through 2018. The data on the amount of rainfall that was obtained by the Department of Irrigation and Drainage (JPS). The highest rate in annual rainfall time series in 2011 is 3695.5mm and the lowest rainfall during 2018 is 428.5mm. The monthly average in figure 2(b) shows the heavy rainfall during seasonal monsoon in November, December and January. The dry season typically occurs from February until May. Figure (c) shows the equivalent water height trends time series (in cm), from 2002 until 2022 at the location study area using the National Centre for Space Studies (CNES) and Groupe de Recherche de Géodésie Spatiale (GRGS) RL05 data. The results of equivalent water height trend show the -0.48 cm per year.
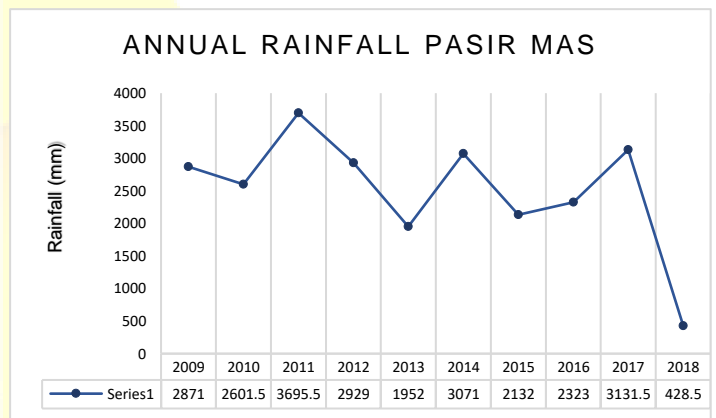
(a)
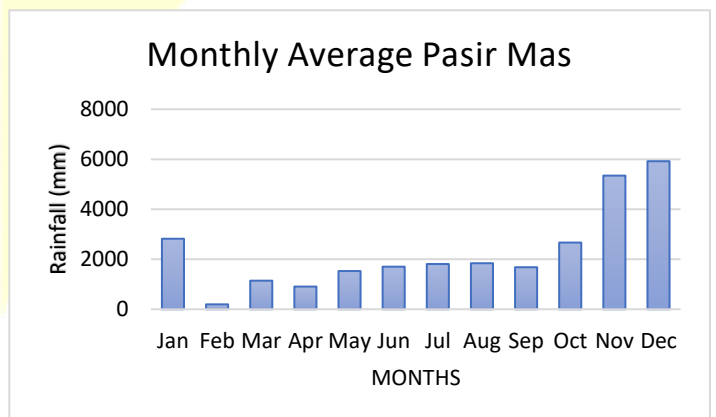
(b)
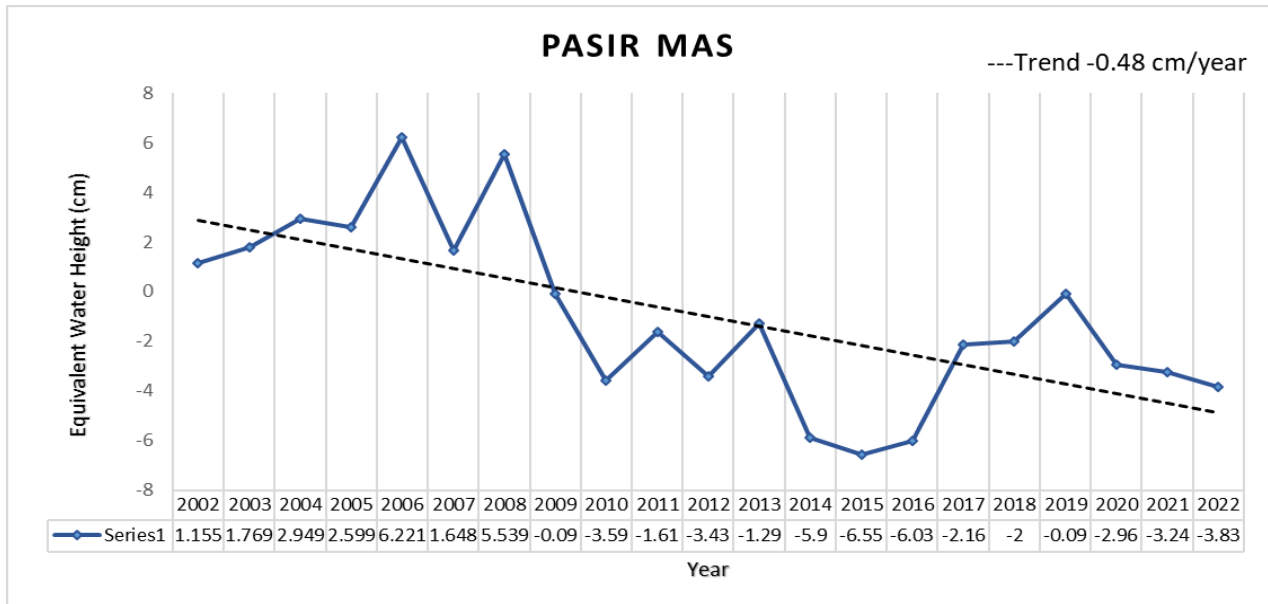
(c)

Figure 3 (a) Annual rainfall (in mm) (b) Monthly average (in mm) and (c) Equivalent water height trends time series (in cm) at the Pasir Mas

Figure 4(a) shows the average annual rainfall in Kota Bharu for the years 2008 through 2018. The data on the amount of rainfall that was obtained by the Department of Irrigation and Drainage (JPS). The highest rate in annual rainfall time series in 2011 is 3033mm and the lowest rainfall during 2018 is 911.5mm. The monthly average in figure 4(b) shows the heavy rainfall during seasonal monsoon in November, December and January. Figure 4(c) shows the equivalent water height trends time series (in cm) at

the location study area using the National Centre for Space Studies (CNES) and Groupe de Recherche de Géodésie Spatiale (GRGS) RL05 data.

The result shows that the equivalent water height also known as total water storage decrease in year 2002 until 2022. Consequently, the amount of equivalent water height decreases is - 0.52 cm per year. From the annual rainfall can conclude that, the trend rainfall is decrease over the year and it effect the trend of TWS.

(a)

(b)

KOTA BHARU ---Trend -0.52 cm/year

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Series1	1.539	2.26	3.383	2.934	6.492	1.812	5.651	-0.1	-3.42	-2.27	-3.62	-1.01	-6.23	-7.25	-6.8	-3.21	-2.86	-5.14	-4	-4.3	-5.53
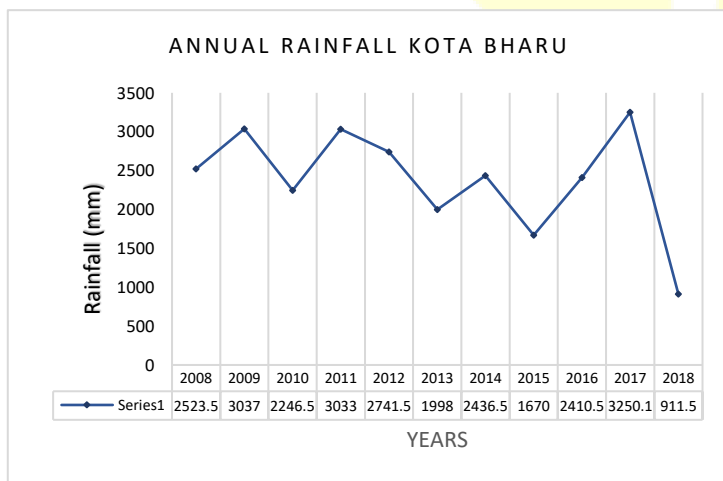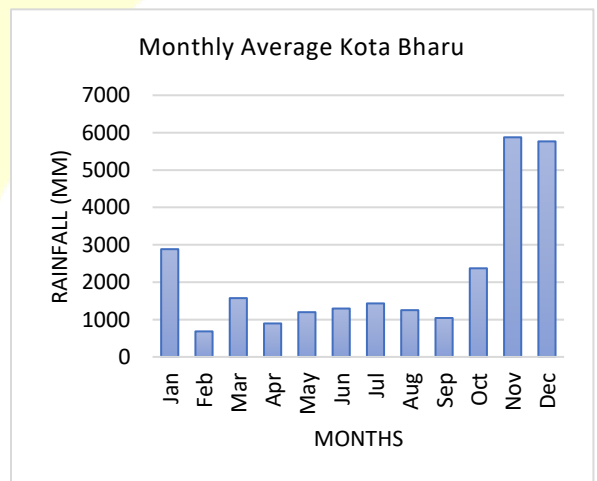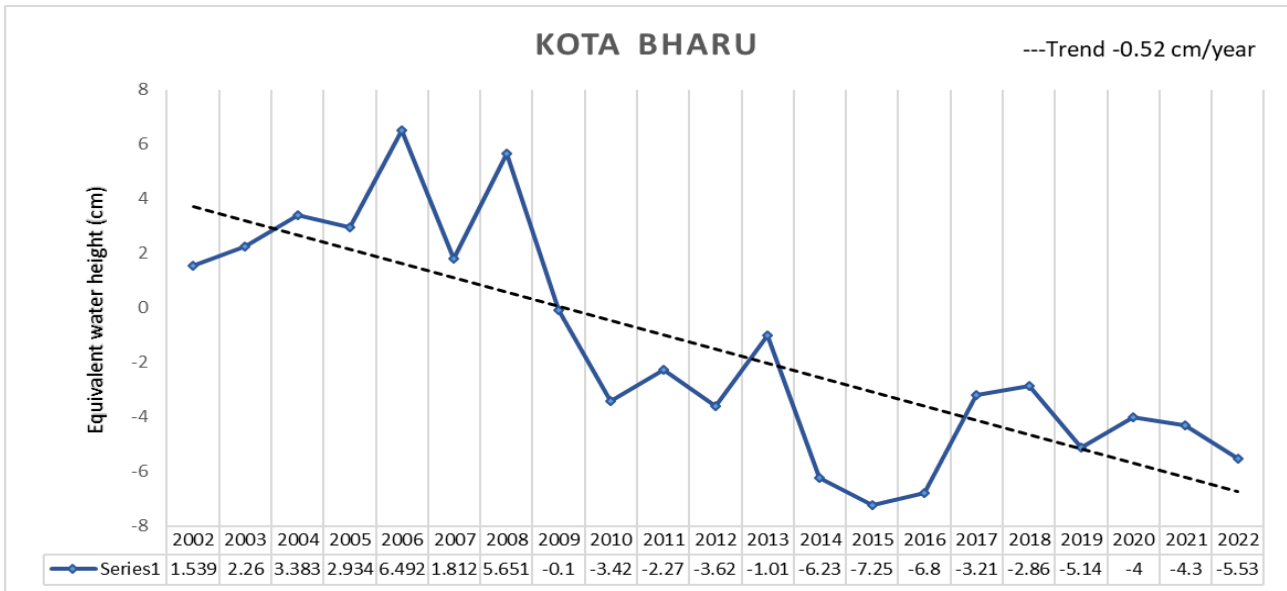
(c)

Figure 4 (a) Annual rainfall (in mm) (b) Monthly average (in mm) and (c) Equivalent water height trends time series (in cm) at the Kota Bharu

3.2 Total water storage (TWS)

The amount of total water storage anomalies demonstrated in figure 5 shows an upward trend subsequent to the high precipitation, followed by a subsequent decline throughout the arid summer period. The highest TWS value is 129.37cm in 2006 and the lowest value TWS is 101.16cm.
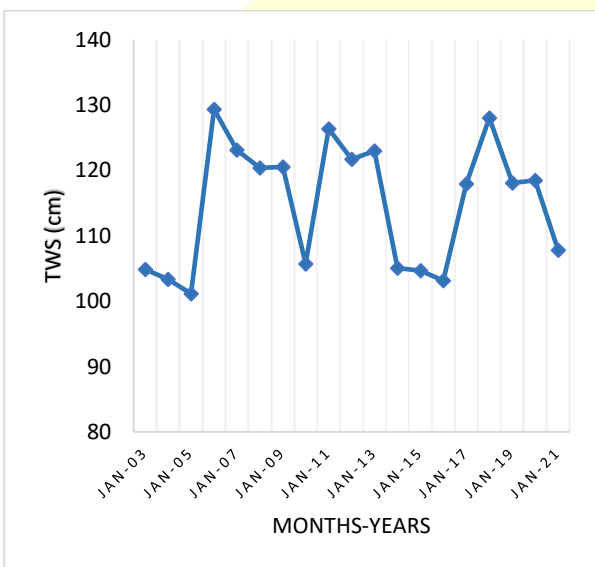
Figure 5 Monthly TWS time series from 2003 until 2021

3.3 Soil Moisture (SM)

In Figure 6(a) shows the soil moisture time series at the study area. The soil moisture anomalies graph is derived from 2000 until 2014. The soil moisture data obtained from GLDAS data. The lowest value is 2.773cm and the highest value is 4.02848cm.
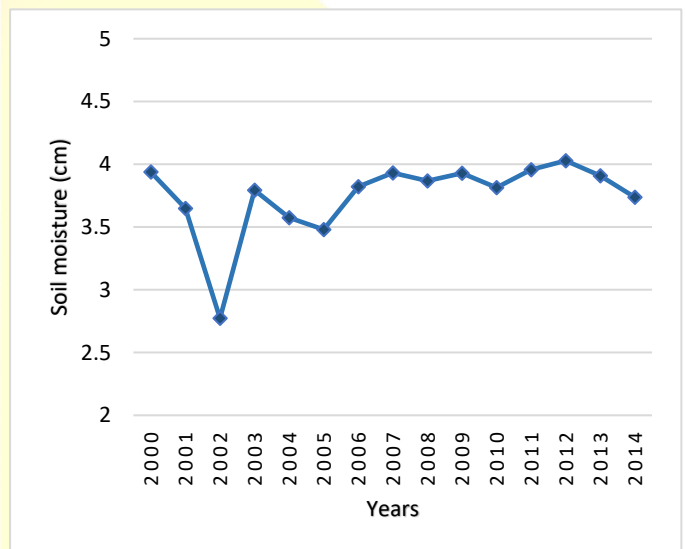
Figure 6(a) Soil moisture time series graph

Figure 6(b) illustrates the spatiotemporal

distribution soil moisture map. The amount of moisture in the soil affects how water permeates the soil and interacts with groundwater. The soil functions as a natural filtration system or buffer for water as it through the surface of the ground. The soil keeps the capacity to assimilate water and so enhance the replenishment of underground water reservoirs.
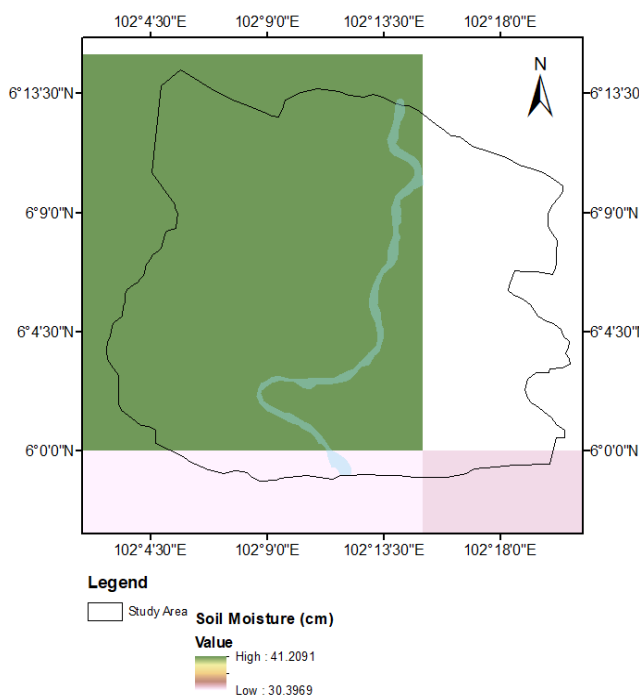
Figure 6(b) Soil Moisture trend map for the study area

3.3 Surface Water (SW)

Surface water is the term used to describe all types of water that is accessible from the surface of the Earth. This includes oceans, rivers, lakes, reservoirs, ponds, and streams. These bodies of water are extremely important components of the hydrological cycle of the Earth. They are responsible for the keep of ecosystems, the provision of water supplies for a wide range of human activities, and the regulation of weather patterns and climate.

In Figure 7(a) shows the surface water

trend map at the study area. The surface water data obtained from GLDAS data. Figure 7(b) shows the surface water anomalies graph from 2000 until 2014. The surface water is highest in 2007 with 0.03167cm and lowest is 0.00177cm in 2004.

Figure 7(a) Surface water trend map for the study area

3.4 Groundwater Storage (GWS)

Series1	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	66.9249	67.6084	66.3667	91.1434	83.8163	81.711	81.2366	67.545	86.8111	81.4126	83.9251	67.6796
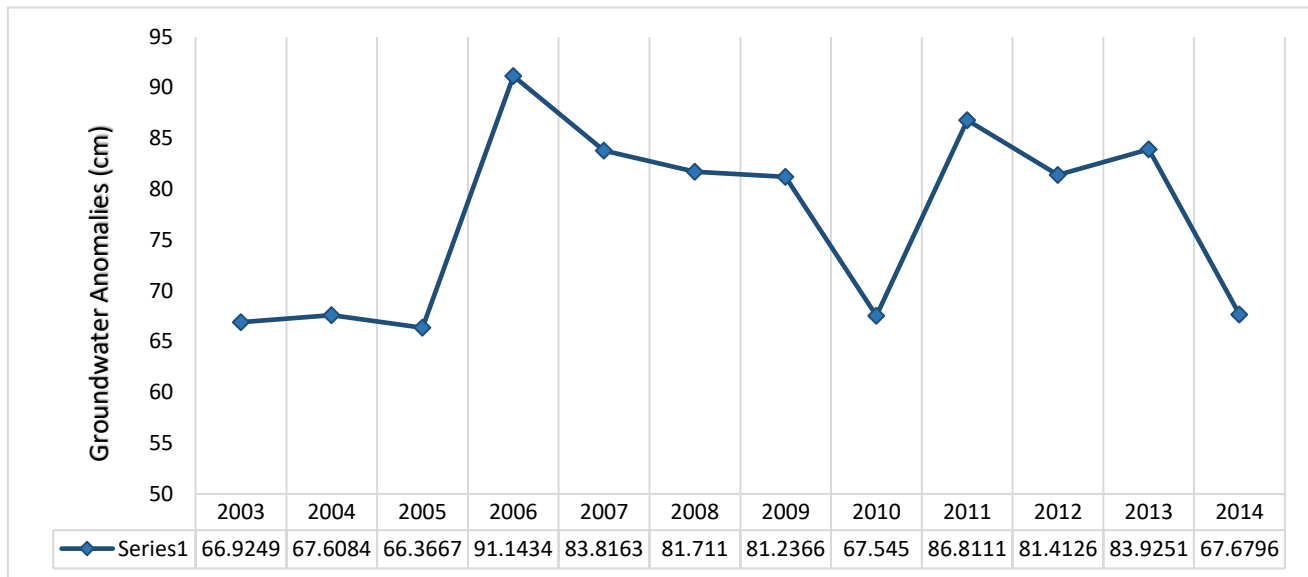
The integration of total water storage data derived from the Gravity Recovery and Climate Experiment (GRACE) with the Global Land Data Assimilation System (GLDAS) yields significant insights about changes in water storage across Earth's land surface, encompassing various components such as groundwater, soil moisture and surface water. The GRACE employs satellite observations to figure out changes in Earth's gravitational field, afterward utilising this data to deduce variations in the distribution of water mass. The equation (1) is used to calculate the groundwater storage. Figure 8 shows the groundwater storage graph between 2003 until 2014. The groundwater storage values for the years 2006 and 2005 were recorded as 91.1434 cm and 66.3667 cm, respectively, with the former being the greatest value and the latter representing the lowest value.

4.0 CONCLUSION

Based on the results obtained from this study, it can be concluded that the GRACE and hydrological data can be used to monitoring groundwater storage in order to control the over exploration of

groundwater. The lack of sufficient data on monitoring wells in the field necessitates the use of GRACE data to extrapolate estimates of the magnitude of groundwater storage in a defined region. This study can further research with groundwater monitoring wells for more analysis about the groundwater storages. The amount of water that can be stored in the ground depends on the amount of precipitation as well as the amount of water that can be absorbed from the soil's wetness.

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COASTLINE CHANGES ALONG JOHOR STRAIT BY USING SENTINEL-1 SYNTHETIC APERTURE RADAR (SAR) IMAGERY

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ABSTRACT

This paper presents the assessment of coastline changes along Johor Straits, Malaysia, using Sentinel-1 Synthetic Aperture Radar (SAR) multi-temporal imageries. The coastline along Johor Straits has been strongly affected by severe erosion and accretion due to climate change and anthropogenic activities. Thus, understanding the causes and mechanisms of coastal morphology changes is important to offer optimal coastal management and protection solutions. This study applied the Digital Shoreline Analysis System (DSAS) developed by the United States Geological Survey to calculate the coastline's rate of change from multi-temporal images from 2018 to 2022. The coastline is extracted by using the *K*-means clustering and then visualised the coastline changes with a map. The results conclude that the Johor Strait experienced significant erosion over the past 5 years and is categorized as "medium erosion" based on the National Coastal Erosion Study (NCES) guidelines.

Keywords: Coastline changes, Johor Strait, Coastal Erosion, Digital Shoreline Analysis System, National Coastal Erosion Study

INTRODUCTION

In general, the coastline is constantly changing due to natural physical changes such as the rise/fall of sea levels, wave effects, and wind movement (Prasad & Kumar, 2014). In addition, anthropogenic activities also play a major role in coastline changes, for example, by landed assets alongshore. These are not only encouraging erosion but also causing the depreciation of landed assets (Oyedotun et al., 2018). The disruption of the coastal area and its ecosystems also causes changes in the coastline. Land reclamation, anthropogenic impact, climate change, and sea-level rise are all putting too much pressure on these ecosystems (Airoldi & Beck, 2007), thus leading to coastal erosion and accretion. Erosion may occur when the wave strikes a feature on the coastline causing the feature to erode over time. Erosion and accretion can have an impact on the physical environment. Coastal erosion is broadly recognized as a significant danger to beach environments (Saravanan et al., 2014). In several localities, the Malaysian coastline has experienced severe erosion, thus risking the local communities and public infrastructure along the coast. Among the government initiatives are conducting the National Coastal Erosion Study (NCES), which discovered that of the country's 8,840 km of coastline, roughly 15 percent, or 1,326 km, is vulnerable to erosion in several categories (NCES, 2015).

Among the severe erosion in Malaysia is along Johor Straits. The coastline experiences an effect from hydrodynamic forces, sediment supply, geomorphology, and antecedent topography with close relations with currents and waves from Malacca and Singapore Straits. For example, Tanjung Piai is classified under Category 1 erosion, where the mangrove forest is critically eroded. The muddy coast is also facing oil spill incidents, which caused the degradation of mangroves and eventually increased the erosion process (Mohamed Rashidi et al., 2021). The coastal erosion has washed away more than 40 meters of mangrove coastline. This shows that the natural protection against coastal erosion also vanished slowly.

Various studies have been conducted concerning coastline changes and erosion. This includes ground surveying using Global Positioning System (GPS) (Smith et al., 2021) and aerial photography (Michalowska et al., 2016). However, this method is costly and time-consuming, particularly for a long shoreline. As an alternative, shorelines can be extracted from satellite imagery analysis (Gens, 2010), including radar (Liu et al., 2016) and multispectral (Behling et al., 2018) and hyperspectral satellite images (Zulkifle et al., 2017). As a cost-effective method for analyzing the coast, the satellite image is frequently used to detect changes in the coastline by establishing a threshold for land and ocean separations. The optical images provide a simple method to extract shorelines based on the spectral reflectance of land and water, however, those images are vulnerable to weather conditions, especially in areas with tropical marine climates. In contrast to optical radiation, radar has different interactions with surface characteristics. To differentiate between land and water (Liu & Jezek, 2004), radar images contrast surface roughness and dielectric characteristics. Moreover, because microwave energy radar can penetrate at night and during cloud cover, it is effective for monitoring changes in coastline positions annually.

This study aims to analyze the coastline changes over Johor Straits from 2018 to 2022, and determine the category of erosion according to Malaysia National Coast Erosion Study (NCES) guidelines. The Johor Straits is situated on the coast of Iskandar Malaysia. Iskandar Malaysia, spanning 2,217 km^2, is an integrated development in Johor with five strategically planned flagship zones with designated economic activities. The 50-kilometer-long Strait of Johor sits between Singapore and Johor at the southern tip of Peninsular Malaysia

DATA AND METHODOLOGY

A. Methodology

Before coastline extraction, the Sentinel-1 images are pre-processed. This includes

applying the orbital files that provide precise satellite position and velocity information. Since the data are obtained from multiple dates, radiometric corrections are required when converting the digital pixel values to radar backscatter in SAR images. The Lee Filter is applied to minimize speckle noise and non–uniform signal characteristics of the signals returning from the ocean surface for calibrated SAR images. Next, filtered images are terrain-corrected using Shuttle Radar Topography Mission (SRTM) digital surface model to fix the geolocation errors due to geometric distortions. *K*-means clustering is applied to classify the water and land. *K*-means clustering is an effective method for identifying and grouping pixels with similar characteristics. Finally, the coastline changes are analyzed using DSAS.

B. Data Resources

The data are obtained from the European Space Agency (ESA) Sentinels Scientific Data Hub from 2018 to 2022. The Sentinel–1 is the radar imaging mission, which provides continuous all-weather day or night imagery for land and ocean services at C–band with a repeat cycle of 12 days (a single satellite) or 6 days (two satellite constellations). The Sentinel–1 IW Level 1 Ground Range Detected (GRD) data acquired in Vertical-Horizontal/Vertical-Vertical polarization. For validating the coastline, the GPS survey has been conducted using Rapid Static Technique. The coordinates of the coastlines are collected at two areas around Stulang Beach and Tanjung Langsat.

C. Coastline Changes Using DSAS

The DSAS calculates the shoreline movement for spatial and temporal scales from the *K*-Means extracted coastline. The transect-based method in DSAS software is used to detect coastline change by creating perpendicular transects between the self-defined reference baseline and multi-temporal coastlines. Transects are created after setting attributes for both coastlines and baselines. The intersection between transects and shorelines will contribute to measurement points that provide location and time information used to calculate the rates of change. After running DSAS, the outputs are values of change and statistical results during the studied period.

In this study, the parameter function in DSAS; Linear Regression Rate (LRR) is used to calculate the coastline change rates and analyze the coastline changes. The LRR statistical parameter is the slope of the least-squares regression line, which uses all available coastlines to estimate the average rate of change over time. The LRR can provide more accurate and objective results when comparing more than two shorelines. The negative values of LRR indicate coastline erosion, whereas the positive sequences refer to accretion.

D. Category of Erosion Based on NCES

After computing the rate of erosion, the Erosion category is classified based on the physical score outlined by the NCES 2015 (Table 2). Through these parameters, the severity of erosion can be identified and proper action can be taken by the authorities.

Table 2. Scoring for physical parameters (source: DID,2015)

Description	Erosion Rate (m/yr)	Physical Erosion Score
Low	≤ 0.99	1 point
	1.00 to 1.99	2 points
Medium	2.00 to 2.99	3 points
	3.00 to 3.99	4 points
High	≥ 4.00	5 points

RESULTS AND ANALYSIS

Figure 7 is the result of *K*-means clustering

to detect the water (in blue) and land (in yellow), and Figure 8 is the extracted coastline.
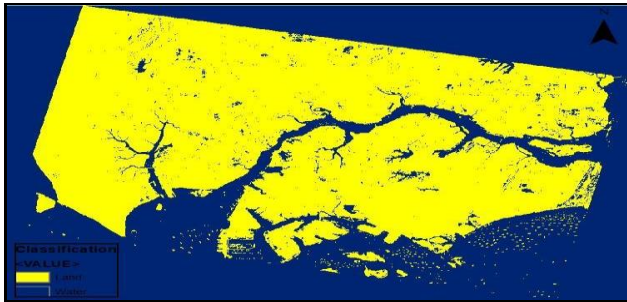
Figure 7. Land-water classification by *K*-means clustering.
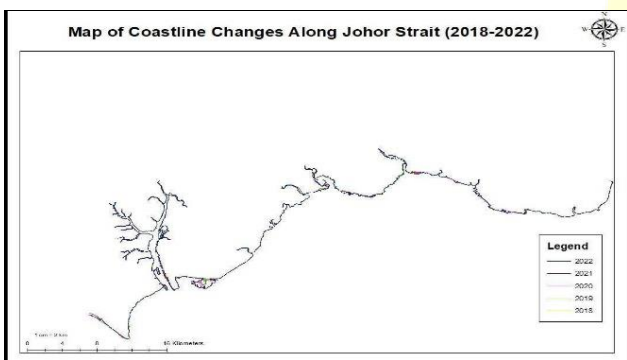
Figure 8. Coastline extraction from 2018 to 2022

A. The Accuracy of Extracted Coastlines

The accuracy of the coastline is assessed by comparing the extracted coastlines with the GPS data. The root means square error (RMSE) of the x and y coordinates are 0.995 m and 0.982 m, respectively suggesting both datasets are in good agreement. The RMSE is calculated from 160 numbers of samples.

B. Coastline Changes for 5 years Period (2018-2022)

The Linear Regression Rate (LRR) technique is used to analyze the coastline changes from 2018-2022. Over the 5 years, the LRR cumulative average rate suggests an erosion trend (-3.44m/yr) for the coastline. The rate of erosion is -7.24m/yr while the rate of accretion is 6.5m/yr (Figure 9). The pattern of erosion and accretion observed along the coast is primarily influenced by tides, waves, riverine inputs, and different types of coastal processes. The introduction of man-made developments is one of the main causes of erosion such as tourism facilities and infrastructures.

Based on Figure 10 and Figure 12, high erosion occurs in Zone A, particularly at Danga Bay and Zone C near Port Tanjung Pelepas (Tanjung Bin). One of the factors that probably contributed to the erosion is the wave from the ship. Although the increase in wave height is not so noticeable, the regularity of the waves from ships affects the soft soil. Another reason for erosion is because of the reclamation and sand dredging process. Due to the reclamation, the area will no longer contribute sediment to the local coastline and thus cause the beach slope angle to increase and the beach profiles to become steeper and increase the erosion rate.

For Zone B (Nusajaya) in Figure 11 and Zone D (Tanjung Puteri) in Figure 13, the rate of erosion and accretion is equal. However, in Zone C, there are accretional patterns in the mangrove areas (Tanjung Piai) and development areas (Forest City). The development and expansion of Forest City as a tourist attraction and economic opportunity indirectly increase the accretion along the coastline. Besides that, this study proves that mangrove areas can act as natural barriers against erosion, except in the area around Tanjung Piai, where erosion continuously occurs despite coastal protection being installed.
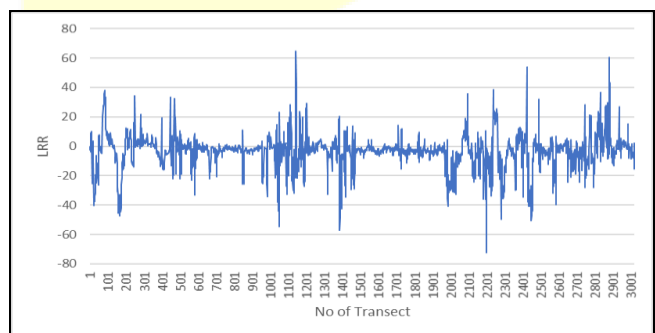
Figure 9. The rate of erosion and accretion using LRR methods from 2018-2022.
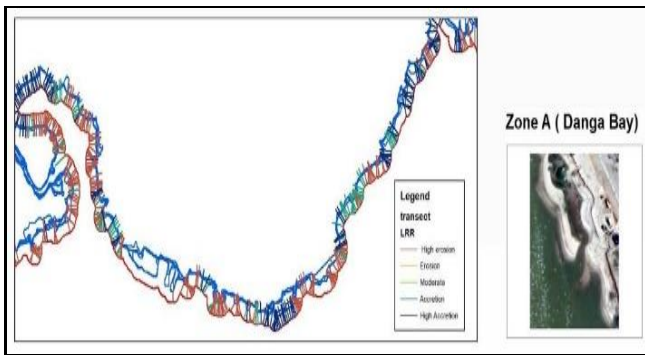
Figure 10. The rate of erosion and accretion using LRR methods from 2018-2022 for Zone A.
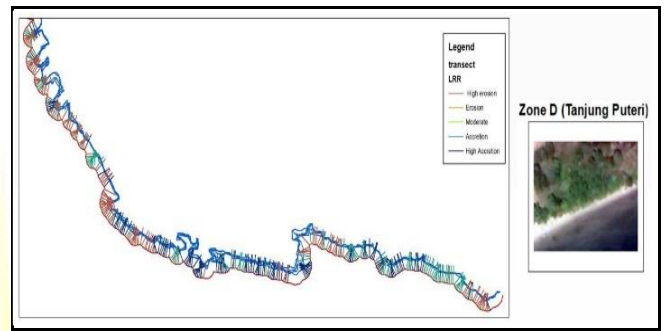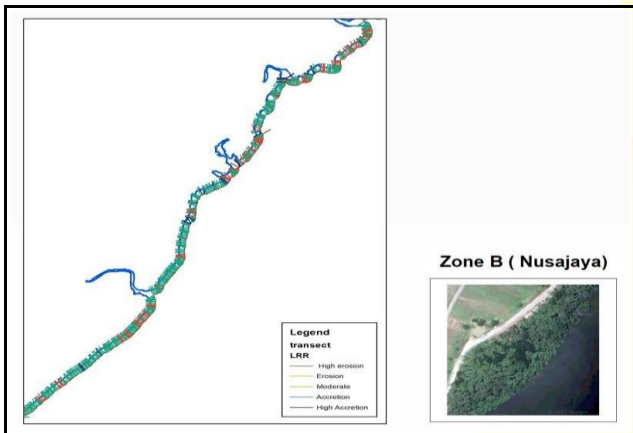
Figure 11. The rate of erosion and accretion using LRR methods from 2018-2022 for Zone B.
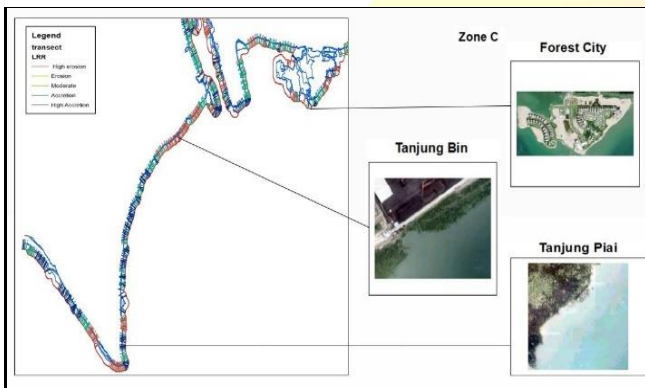
Figure 12. The rate of erosion and accretion using LRR methods from 2018-2022 for Zone C.

Figure 13. The rate of erosion and accretion using LRR methods from 2018-2022 for Zone D.

C. Erosion Category Based on NCES

Table 3 summarizes the overall rate of erosion (-7.24 m/yr) and accretion (6.5 m/yr) and the average over the five years (-3.44 m/yr). Based on the NCES parameter score in Table 2, the physical erosion score is 4. This indicates that erosion in Johor Straits is considered "medium" erosion.

Table 3. Variation of the coastline from the LRR using the five years coastline period.

Period	Erosion (m/yr)	Accretion (m/yr)	Average(m/yr)
2018-2022	-7.24	6.5	-3.44

CONCLUSION

The study attempted to track shoreline shifts for five years from 2018 to 2022, using the *K*-Means clustering for coastline extraction and DSAS for analyzing the coastline changes. Based on LRR statistical techniques, the overall rate of erosion is -3.44 m/yr, which falls under the physical erosion score of 4 on the NCES guideline. This concludes that erosion in the Johor Straits is a "Medium" erosion category.

Future research is undergoing to conduct a detailed analysis of erosion based on the NCES on a smaller scale for each zona in Iskandar Malaysia.

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WHAT IS THE LANDCOVER INTERFEROMETRIC NOISE PATTERN OF SENTINEL-1 SAR IN THE VEGETATED HUMID TROPIC?

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ABSTRACT

Synthetic aperture radar interferometry (InSAR) is a valuable technique for measuring three-dimensional (3D) earth's surface information, such as the Digital Elevation Model (DEM), but it is often affected by various noise sources such as atmospheric disturbances, sensor calibration errors, and variations in surface scattering. However, with Sentinel-1's stable ephemeris, volume scattering is the most significant source of noise in the vegetated humid tropics. Thus, understanding the effect of landcover on interferometric noise is critical for accurate and reliable interpretation of InSAR measurements in this complex and dynamic region. Therefore, this paper analyses the Sentinel-1 SAR generated interferogram noise patterns over landcover types within the vegetated humid tropics. Suitable Sentinel-1 SAR pairs acquired over part of Johor in Peninsular Malaysia were processed using the Sentinel Application Platform (SNAP) and the InSAR processing chain to generate the interferograms. The interferometric phase over selected landcover is analysed accordingly. The preliminary findings show distinct noise patterns associated with various landcover types. Interferometric noise levels are lower in built-up areas, which are defined by man-made structures and dense urban environments. Other dominant non-built-up landcover in the study area, which include forest, water body, and oil palm landcovers, showed relatively higher levels of interferometric noise. By comparing the interferometric noise pattern across different landcover types, this study shall contribute to a better understanding of the noise sources in SAR interferometry in the vegetated humid tropics. The study's findings have implications for the interpretation of InSAR measurements and provide valuable insights for future SAR-based applications in this ecologically diverse and challenging region.

Keywords : fringe, phase noise, interferometric phase profile

INTRODUCTION

Interferometric synthetic aperture radar (InSAR) is a technique that utilizes the phase difference between two synthetic aperture radar (SAR) images to generate an interferogram, providing valuable information about the Earth's surface (Massonnet & Feigl, 1998; Shiping, 2000; Zhou et al., 2009). The interferogram consists of both amplitude and phase components, with the phase depicting the phase difference between each pixel (Ullo et al., 2018). Through pixel-by-pixel cross multiplication of the reference and secondary SAR images, the interferogram reveals displacements and deformations of the area of interest, making it a powerful tool for various applications such as topography mapping, surface deformation analysis, and monitoring of natural hazards (Maitre, 2008; Mondini et al., 2021; Zhou et al., 2009); characterisation of wetlands water level change (Hong et al., 2010; Wdowinski et al., 2008); coseismic stress changes (Massonnet & Feigl, 1998); and soil moisture variation (Zhou et al., 2009).

However, generating an accurate interferogram relies on the preservation of signal phase coherence between the two images (Schultz & Engman, 2000). Coherence serves as an indicator of the quality and reliability of the interferogram, with higher coherence values suggesting a good quality interferogram (Zhang & Prinet, 2004) and vice versa. In fact, measurement of phase difference is said to be severely compromised where coherence falls below 0.3, rendering interferogram phase information virtually useless (Chindo et al., 2022b). Several factors, including baseline, atmospheric effects, satellite orbits, surface topography, dielectric properties, and Doppler Centroid difference, can influence interferogram quality (Zhang & Prinet, 2004; Zhou et al., 2009). Consequently, the interferogram phase inherently contains noise (Li et al., 2006; Simons & Rosen, 2007; Zebker & Villasenor, 1992).

In the vegetated humid tropics, where Sentinel-1's stable ephemeris presents an opportunity for consistent measurements, higher interferometric noise is mainly due to volume scattering over vegetated surfaces (Chindo et al., 2022a). However, the lower frequency employed by Sentinel-1, can further reduce coherence, posing challenges for accurate interferogram generation (Zhang & Prinet, 2004). Thus, understanding the effect of landcover on interferometric noise and the noise patterns associated with different landcover types within the vegetated humid tropics is crucial for the reliable interpretation of interferometric measurements in this complex and dynamic region.

This paper therefore analyses the interferometric noise patterns generated by Sentinel-1 SAR over various landcover types within the vegetated humid tropics, an aspect that has received limited attention. By investigating the noise patterns caused by different landcover categories, ranging from built-up areas to natural lands such as forest and water bodies, and agricultural lands such as oil palm landcover, this study seeks to contribute valuable insights to the knowledge base of the geoscientific community. Moreover, the results will facilitate informed applications of interferometric SAR (InSAR) in the humid tropics, ultimately enhancing accuracy and reliability in geospatial interpretations in this complex and dynamic region.

MATERIALS AND METHODS

This study was carried out in part of Johor, within latitudes 1^0 20' and 2^0 0', and longitudes 103^0 25' and 104^0 15' (Figure 1), in Peninsula Malaysia. The area enjoys a humid climate with two monsoons and inter-monsoons'. Because of the climate, natural forest and plantations make up a significant part of the area (Obaid & Shahid, 2017), with patches of dense built-up and surface water bodies (Chindo et al., 2023).

A suitable pair of Sentinel-1 single look complex (SLC) SAR images with a perpendicular baseline within the recommended range (Chindo et al., 2022b) concisely described in Table 1, were the main data utilised for this study. The images were freely downloaded from the Alaska Satellite Facility (ASF) (ASF, n.d.). The Copernicus open-source DEM was used as supplementary data for coregistration.

The Sentinel Application Platform (SNAP) was used to process the SAR images in line with the InSAR processing workflow in Chindo et al. (2022b), down to the interferogram formation stage.

To analyse the interferometric noise patterns over various landcover types, four dominant distinct landcover (built-up, oil palm, natural forest, and water body) regions were identified (Figure 1). Diagonal phase profiles p1-p2, p3-p4, p5-p6, and p7-p8 (Figure 1) were first plotted. Then phase values within the respective landcovers were classified pixel-by-pixel into signal and noise by thresholding based on coherence since phase values are compromised or even useless at below 0.3 coherence values (Chindo et al., 2022b; Woodhouse, 2006). Consequently, the signal-to-noise ratio (SNR) for the respective landcovers was determined based on Equation 1.

$$SNR = \frac{signal}{noise}$$ --------------------------------(1)

Where signal is the mean value of the signal and noise is the standard deviation of the noise.
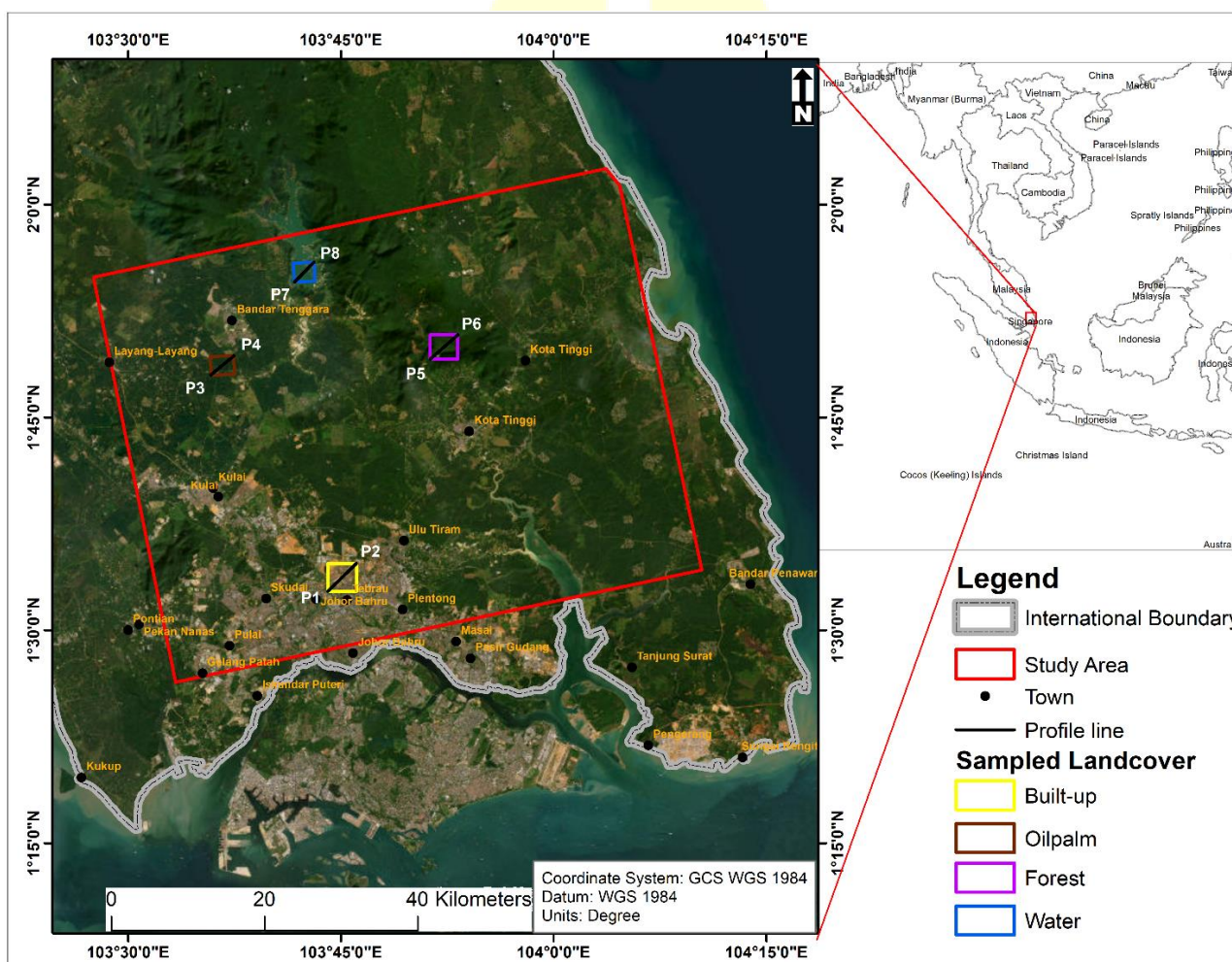
Figure 1 Study area

Table 1 Details of Sentinel-1 SAR used.

S/N	Status	Scene ID	Acquisition Date	Swath/ Burst	orbit	b_perp (m)	b_temp (days)
1	Reference image	S1A_IW_SLC__1SDV _20220402T112530_2 0220402T112557_042 593_0514C6_2D22	02/04/2022	IW3/	Asc	-	-
2	Secondary image	S1A_IW_SLC__1SDV _20220508T112532_2 0220508T112559_043 118_052642_D42A	08/05/2022	IW3/	Asc	155	36

*Notes: b_perp = perpendicular baseline, b_temp = temporal baseline, IW = interferometric Wide, Asc = Ascending

MAIN RESULTS

The phase profiles corresponding to different landcovers, as depicted in Figure 2, reveal distinctive characteristics. Notably, the phase noise is more pronounced over water and forest landcovers, exhibiting the highest and lowest peaks, respectively. In stark contrast, the built-up landcover exhibits significantly lower noise levels, as convincingly illustrated in Figure 3. Further analysis, as shown in Figure 4, elucidates that built-up landcover boasts the highest Signal-to-Noise Ratio (SNR), suggesting that signals and noise are most discernible over built-up areas relative to other landcovers. Conversely, forest landcover exhibits the lowest SNR, followed by water bodies and oil palm landcovers in descending order.
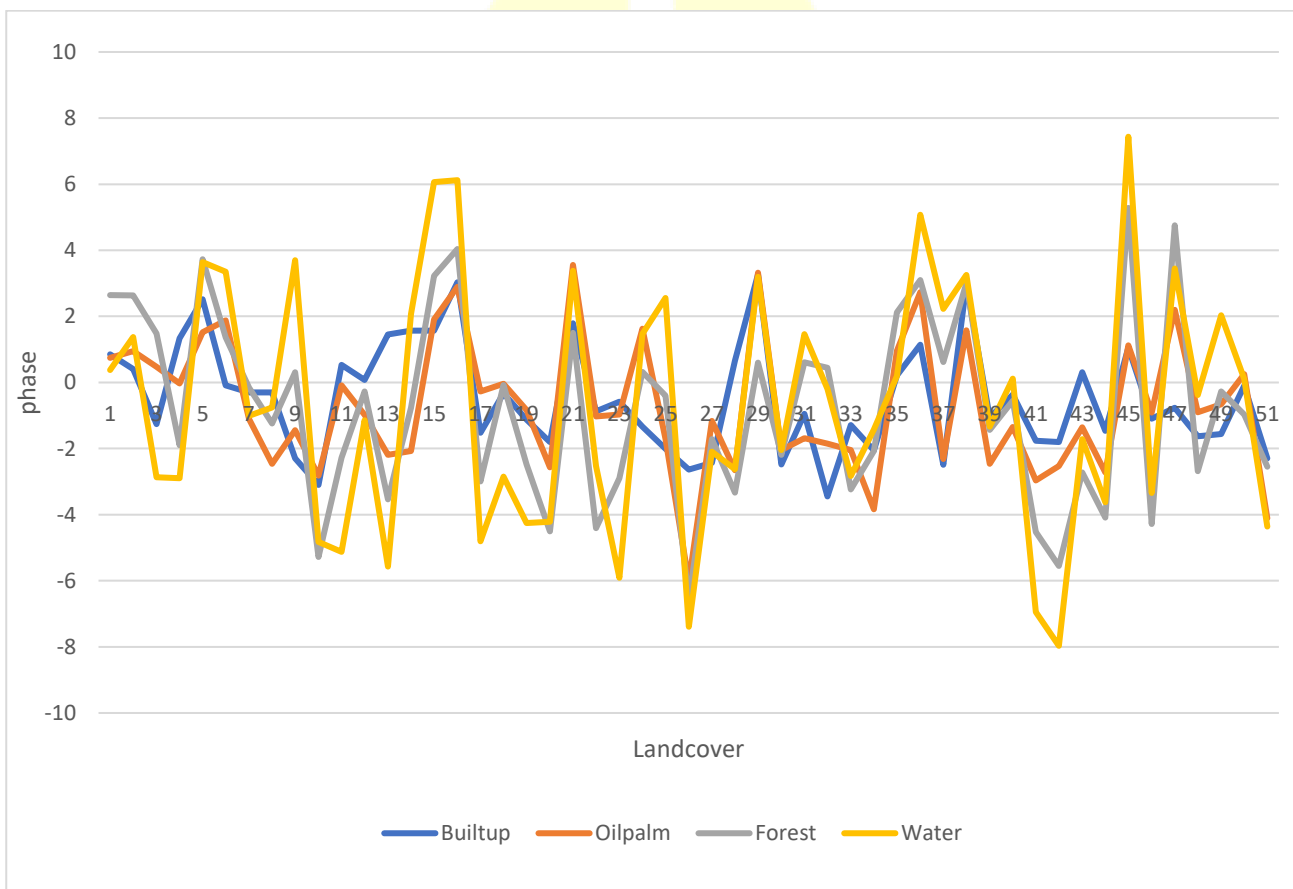
Figure 2 Phase over different landcover
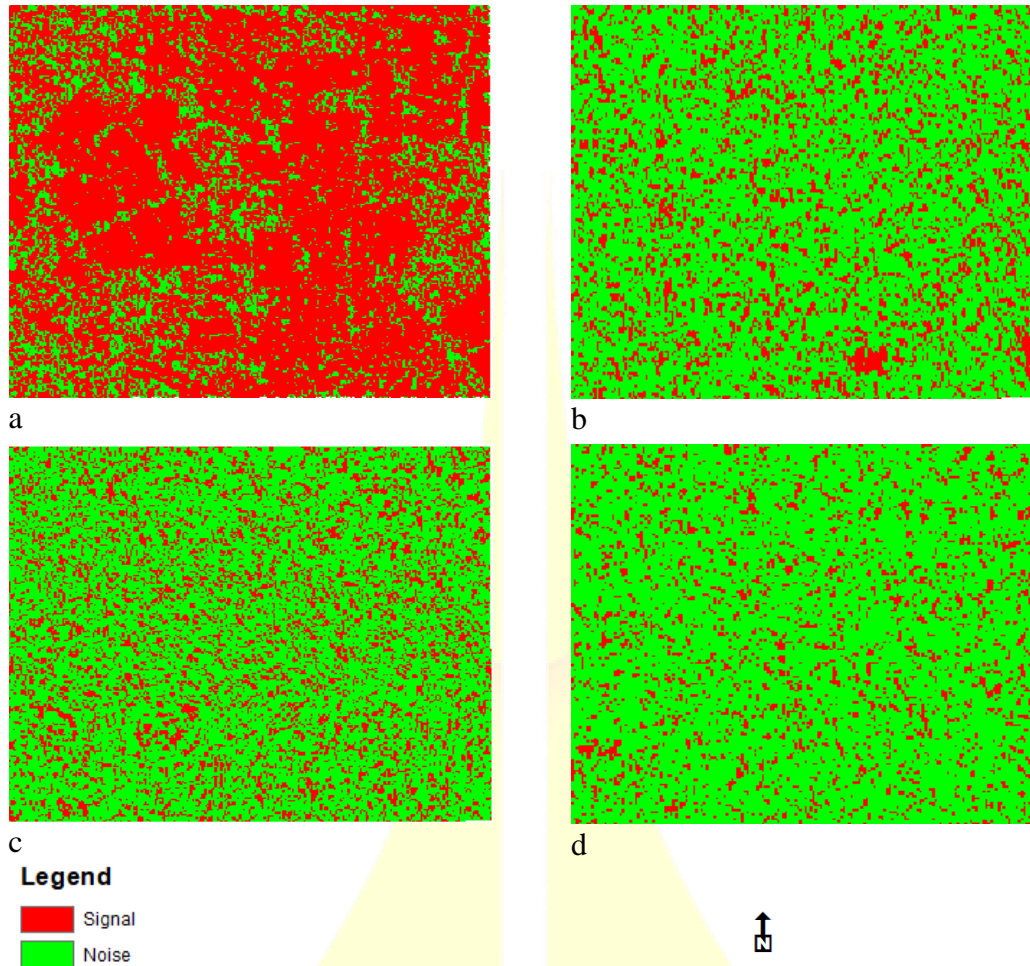
Figure 3 Signal and noise over different landcovers. a = built-up, b = oil palm, c = forest, d = water
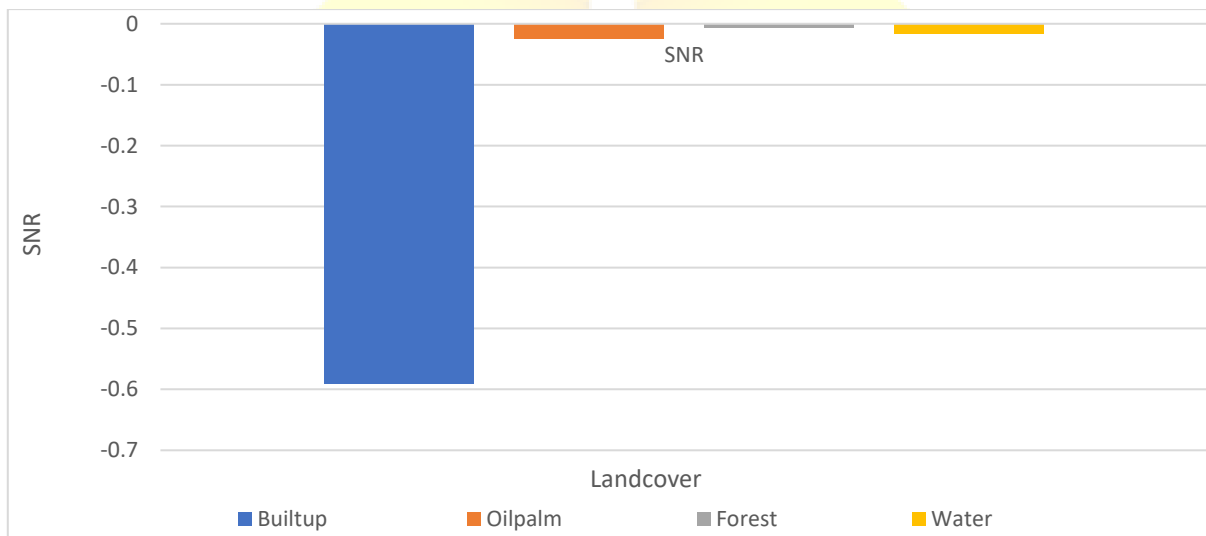
Figure 4 Signal-to-noise ratio over different landcover

This comprehensive examination of the phase noise over diverse landcovers provides valuable contributions to the understanding of signal propagation and noise characteristics in the vegetated humid tropics. The observed higher phase noise over water and forest landcovers may be attributed to specific environmental factors unique to these areas, such as vegetation density, surface water interactions, and topographical features. On the other hand, the notably lower phase noise in built-up landcovers suggests an improved signal propagation

environment due to urban structures.

The remarkable contrast in SNR among landcovers further underscores the significance of this study's findings. The higher SNR observed in built-up regions implies that signal extraction and analysis in these areas could yield more accurate and robust results. Contrarily, the lower SNR in forested regions could be attributed to the complexities introduced by vegetation scattering and absorption of electromagnetic waves, rendering the detection of signals challenging in such environments. Meanwhile, water bodies and oil palm landcovers, exhibiting intermediate SNR values, reflect unique challenges and opportunities in their respective applications.

CONCLUSION

This study presents a comprehensive analysis of phase noise in the vegetated humid tropics, yielding valuable insights into signal propagation and noise characteristics in such Dynamic environment. The results reveal a clear distinction in phase noise levels among landcovers, with water and forest areas exhibiting higher phase noise, while built-up regions demonstrate significantly lower noise levels. Moreover, the built-up landcover displays the highest SNR, indicating a more favorable environment for signal extraction and analysis compared to other landcovers, whereas the forest landcover exhibits the lowest SNR, followed by water bodies and oil palm landcovers. The study deepens comprehension of phase behavior across landcovers in the vegetated humid tropics, and lays the foundation for further research in exploring novel techniques to enhance signal reliability, reduce interference, and optimize data transmission in various geographical contexts. Moreover, this knowledge could aid in the development of intelligent algorithms and signal processing techniques tailored to specific landcover conditions, ensuring more efficient and accurate data analysis and interpretation,

which could have profound implications for applications such as remote sensing, and environmental monitoring with interferograms in the vegetated humid tropics with especially Sentinel-1 SAR in particular, and InSAR application in general.

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INTEGRATION OF AIRBORNE UAV LIDAR AND TERRESTRIAL LIDAR SYSTEM FOR ACCURATE 3D BUILDING MODEL CONSTRUCTION

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ABSTRACT

The significance of three-dimensional object modelling has grown exponentially due to its ability to present the information in an actual dimension. Advancements in computing, robotics, programming, and sensors have further accentuated the importance of 3D modelling in numerous fields and applications. The 3D building modelling, a prominent application within the realm of 3D, provides valuable information that supports and helps the government agencies in managing and developing nationally. Various techniques have been utilized worldwide to model the building, with the light detection and ranging (LiDAR) regarded as one of the best techniques because of its ability to generate very high accuracy and very dense point cloud data. However, with various LiDAR systems available worldwide, integrating diverse sets of point cloud data from multiple LiDAR platforms present an opportunity to construct precise 3D building models. Consequently, the primary objective of this study is to construct an accurate three-dimensional building model by utilizing point cloud data acquired from three different LiDAR systems. Furthermore, a comprehensive investigation was conducted to assess the efficacy of integrating point cloud data from diverse LiDAR platforms. This research was conducted in Lingkaran Ilmu, Universiti Teknologi Malaysia, an area comprised of diverse objects, including buildings, roads, trees and featuring topography with significant slope variations. Airborne UAV LiDAR, mobile laser scanning (MLS) and backpack LiDAR were specific LiDAR platform employed in this study to acquire very dense point cloud data of building from distinct perspectives. The accuracy of the resulting 3D building models was assessed using the RMSE equation, a statistical approach. As a result, 3D building models with an RMSE error of ±0.015 meters (planimetric) and ±0.009 meters (height) were successfully generated. In conclusion, the integration of point clouds obtained from diverse LiDAR systems holds promise for producing precise 3D building models. This research highlights the potential benefits of leveraging integrated LiDAR systems in the pursuit of accurate and detailed representations of buildings.

Keywords : unmanned aerial vehicle, LiDAR, photogrammetric, 3D building model

INTRODUCTION

In the era of digitization, three-dimensional object modelling has undergoing augmented development, where the physical structural of the object is transformed into digital form for more effective and efficient management, storage, and visualization purposes. The digitization process of physical object can be divided into three main forms, either two-dimensional, two point five-dimensional and three-dimensional. Basically, the selection of these digital forms depends on the purpose and requirements of a project and application. Apart from that, each forms have differences from the aspect of structure and detail. As compared to the other forms, the 3D form has more complex structure and higher level of detail. Therefore, lots valuable and useful information can be extracted from this form and this information is visualized in the form of real environment. Nowadays, many important bodies like government agency and department are moving towards 3D modelling application due to this information can be used for development and planning to become a developed country in the future. In geospatial discipline, various technique has been used to develop 3D modelling object such a LiDAR, close-range photogrammetry, remote sensing, and others. Among of this technique, LiDAR technology capable to produce an accurate and higher detail of 3D model object because it's equipped with more advance and higher accurate laser system for obtaining the distribution of point cloud data. LiDAR also available in variety form and system which is each form will provide different result. Thus, the purpose the study is to evaluate the influence and effect of the integration from different LiDAR system towards 3D building object.

THREE-DIMENSIONAL OBJECT MODELLING

A three-dimensional object modelling can be defined as a comprehensive process that begins with data collection and finishes with an interactive three-dimensional virtual model on a computer. Henceforth, the process of 3D modelling involves the transformation of physical objects or features into three-dimensional form representation by manipulating the polygon, edge and node of the object or feature. In the field of computer graphics, three-dimensional modelling is the process of transforming an image based on the mathematical coordinates of any object surface into a three-dimensional form by manipulating edges, nodes, vertices, and polygons in a simulated three-dimensional space. Basically, transforming a two-dimensional form into a three-dimensional form can be accomplished through either manually or automatically by deforming the mesh. Specialized software is used to manually construct or modify the edge, polygon, vertices, and nodes, or advanced equipment is used to scan a physical structure of the object then transform it into a digital form. These manipulation processes are mapped onto a three-dimensional grid and joined as polygonal shapes, typically triangles or quadrangles. Each point or vertex has its own coordinates on the grid and by combining these points or vertices into shapes for producing surface of the object. At present, there are numerous varieties of three-dimensional software on the market, including AutoCAD 3D, ZBursh, 3DS Max, SketchUp, Blender, and others. The impact of this development has caused a high demand for three-dimensional modelling for the use of three-dimensional modelling to fulfill the critical need from the public and private sectors. Therefore, there are various field have exploited the benefits of three-dimensional modelling for achieving their goals and interest such as geospatial, medical, engineering, architectural, entertainment, urban planning, special effects, game development, commercial, inspection and others. The Visualization of the real-world object into three-dimensional form enables the complete extraction of information from real-life situations and cases. Figure

1 shows examples of three-dimensional objects.

Figure 1 show example of three-dimensional object model.

In this regard, beneficial information is used to assist industries in making accurate, rapid, and economical decisions regarding problem resolution. This innovation has helped those industries to improve their service quality and fulfil their consumer responsibilities more efficiently. Three-dimensional building modelling or city modelling is one of the core applications in this discipline. In relation to that, many nations, particularly developed and developing nations have developed three-dimensional city model for variety of purposes including cadaster database, urban planning visualizations, spatial planning in early stage, calculation floodplains, drainage calculations, issuing of building permit, Noise and environmental analyses and so on. Stadler & Kolbe (2007) define three-dimensional city models as digital representations of the Earth's surface and related objects belonging to urban areas. In addition, city model encompassed to the process of creating virtual visualization of features such as building, vegetations, roads, man-made object, infrastructure, and topography. In discussing issues related to three-dimensional modelling, it is essential to emphasize the level of detail (LOD). LOD refers to the level of complexity in a three-dimensional generated model. Basically, this LOD is divided into five categories which is LOD1 until LOD5. Where, LOD5 construct the model at an

extremely complex level relative to the other categories. Figure 2 shows the difference between these categories of LOD. There are numerous methods and technologies that have been employed in developing three-dimensional city models such as LiDAR, photogrammetry, remote sensing and so on. Among these techniques, the LiDAR approach is frequently used to develop the three-dimensional model. This is due to the fact that LiDAR is capable of producing better and more accurately compared to other methods, even the model contains object or feature with a highly complex and unique structure and shape. Nevertheless, the use of LiDAR data demands high and expensive cost as well involves the management and processing of a huge size of data and very complicated.
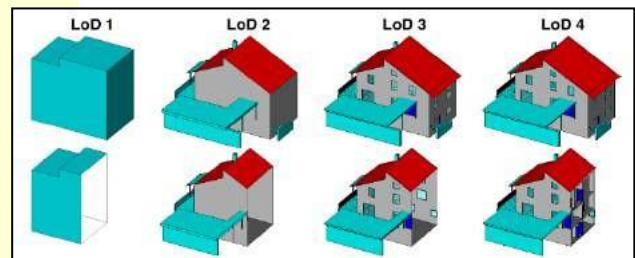
Figure 2 show The Differences between LOD1 to LOD4

LIDAR SYSTEM

LiDAR is the most precise technique for acquiring highest dense and high accurate point cloud information of each feature on the earth's surface. This LiDAR data be capable of produce information with accuracy up to ±15 centimetres for planimetric coordinate and ±55 centimetres for height coordinate. LiDAR is an abbreviation of the term Light Detection and Ranging. Practically, laser radiation is used to scan object and feature on the earth's surface as well provide a distribution of point cloud data containing position and height information. In general, a laser beam is emitted towards a feature on the surface and reflected to the receiver in order to determine the duration it takes for the laser beam return to the receiver. This calculation is carried out according to

Equation 1, where the position and height of the object or feature is determined with better accuracy by calculating the light reflection time for each pulse return to the received. It has evolved into a technique for obtaining precise and accurate high-density point clouds for three-dimensional topographical surfaces. The use of radiation in the LiDAR system is highly suitable and efficient because the laser is capable of moving at the speed of light. This is further supported by the fact that lasers as electromagnetic radiation that is coherent, convergent and monochromatic.

$$d = c * (t/2) \ (Eq1)$$

Where,
d = Distance from sensor to target (m) c = Speed of light (3 x 108 m/s)
t = Time taken for the pulse return to receiver (sec)

Basically, LiDAR falls under the concept of remote sensing due to the principles used to obtain and interpret important information without directly touching the objects being investigated. Apart from that, the laser radiation emitted from the LiDAR system does not required energy from the sun because the system employs active sensor to generate energy and is capable of obtaining distribution of point cloud data at entire time. Figure 3 depict the principal of LiDAR system acquire the information. The production of high resolution and accurate data enables more efficient mapping activities for a variety of application, including 3D modelling, planning, topography mapping, slope analysis, forestry, and so on. In addition, LiDAR system comprises of importance component including platform, sensor, Global Navigation Satellite System (GNSS), Inertial Measurement Unit (IMU) and workstation.
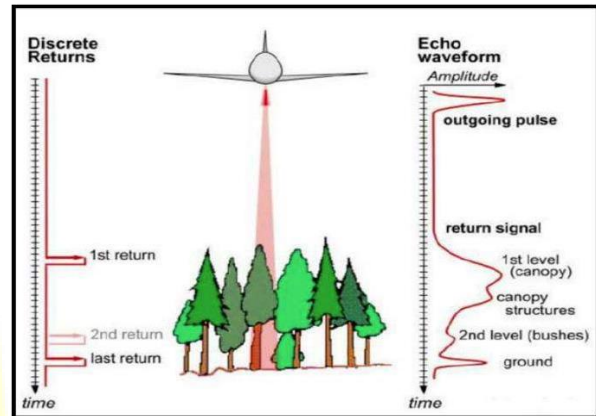
Figure 3 show the principal of data acquisition using LiDAR system.

In general, LiDAR system are classified into three main class known as airborne LiDAR system (ALS), terrestrial LiDAR system (TLS) and space LiDAR system (SLS). Each class has different between each other, especially in terms of the platform used. Regarding with ALS, the platform used is on the aerial during the acquisition of point cloud data. Among the platforms commonly used in this class are man aircraft and drones. In this class, man-made aircraft and unmanned aerial vehicle system are common platform. Where, man-made aircraft refers to an airplane that has pilot in the cockpit integrated with LiDAR sensor and metric camera. Typically, this platform is capable of performing laser scanning from a higher altitude than drone. However, its implementation is costly and highly dependent on many factors. While the integration between drone and LiDAR system is becoming a trend at this moment because the benefits of this integration offer a reasonable cost and are quite flexible. Nevertheless, both platforms are suitable used for acquiring distribution of point cloud data from nadir perspective or aerial view at almost the same data accuracy. As for TLS, the platform is divided into two form, namely mobile and stationary. Mobile platform uses object or device that moving during data acquisition such human operator and vehicle. For a stationary platform, the position of the sensor is fixed and does not move, also placed on a tripod. Usually, data acquisition is done from a horizontal

perspective such as scanning façade and structure wall of the building. also, it frequently used for scanning vertical structural. In addition, laser scanning from TLS can be done on the interior and exterior of the object. For the last class, SLS involves the of satellite as a platform and orbit in the outer space. The information from SLS frequently used for various purpose and application like monitoring volcanic sulfur dioxide, diurnal cycle of cloud profiles over land/ocean, atmospheric study and so on. As discussed, LiDAR data is stored in the form of discrete points known as point clouds. According to American Standard Code for Information Interchange (ASCII), LiDAR data is usually saved in laser format (. las). Furthermore, LasTools has introduced another format for LiDAR data known as Laz format (. laz), which is compressed of laser format (. las). meanwhile, the output data generated from scanned data are saved in a file with the extension ".tiff. Figure 4 show the example of LiDAR platform available in the market.

Figure 4 show example of LiDAR platform

STUDY AREA

The study area was conducted in the central part of the Universiti Teknologi Malaysia (UTM), having an area of 60 hectares. This area is the main campus area of the university campus is built on a small hill and a ring road surrounds it. The ring road is known as Lingkaran Ilmu. It is

located at coordinates 172957.69m (Top), 347951.55m (Left), 349070.48m (Right) and 171999.49m (Bottom) based on the Universal Transverse Mercator (UTM) zone 48N coordinate system. According to Najad et al. (2018), this area was developed based on the radial concept where it is built on a hill and has a gentle slope. This area's elevation varies from 20 m to 107 m above the mean sea level (MSL). This study area comprises five faculties, two administration buildings, a mosque, a library, and the main hall. The buildings were built inside this study area such as the Faculty of Built Environment and Surveying, Faculty of Science, Faculty of Civil Engineering, Faculty of Mechanical, Faculty of Science Social, Masjid Sultan Ismail, Dewan Sultan Iskandar, Canceler building, Student Welfare building and Sultanah Zanariah Library. The entire buildings block located in this area is more than 20 blocks. These blocks have a complex structure and are surrounded by trees, roads, and grass. Figure 5 illustrates the location of the study area.

LINGKARAN LIMU
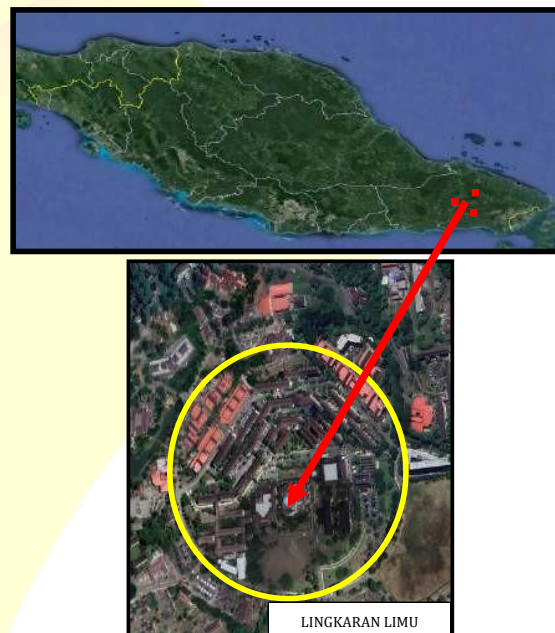
Figure 5 shows the location of study area from the aerial view and Google

DATA COLLECTION

In order to accomplish primary objective of this study, three different LIDAR system

were employed to acquire distribution of point cloud data in the study. UAV LiDAR, MLS LiDAR, and Backpack LiDAR used for scanning the features and objects contained within area of Lingkaran Ilmu from horizontal perspective and aerial view. For this reason, the laser scanning was conducted from various different perspective for acquiring the complete point cloud data distribution for entire feature in the study area, particularly the building. This is further supported by facts that UAV LiDAR system has difficulty and limitation to scan the building from every angle because the existence of opaque objects that block the laser radiation emitted reach the entire structure of the targeting features such as car, tree canopy, gazabo, and so on. In additional, the laser beam emitted from UAV LiDAR system almost covers the entire part of horizontal structure and the upper part of vertical structure. Based on this issue, MLS LiDAR and Backpack LiDAR system have been utilised to acquire distribution of point cloud data for area or part not covered by UAV LiDAR. These systems have the advantages to scanning object from close range and at difficult angle. Figure 6 shows all three LiDAR system used for collecting distribution of point cloud data in the case study.

Figure 6 shows three LiDAR system used for data acquisition in this case study

During object scanning, the RiEGL VUX LiDAR sensor is integrated with the UAV octocopter and equipped with a 24-megapixel of non-metric camera. This system is flown at an altitude of 100-metres above the ground level in semi-automatic mode using standard pattern flight line. The process of scanning object from aerial view is fully controlled by the operator in the field with the aid of monitor from the flight planning software. Moreover, the camera angle was changed to 90-degree position to capture aerial photo of each feature in the study area. In general, information from the aerial photo will be interpreted and extracted to be used in colorizing the point cloud data. As discussed, the use of MLS and Backpack LiDAR system are essential and necessary for acquisition of point cloud data from horizontal perspective. MLS LiDAR is integrated with four-by-four vehicle and also equipped with a 20-

megapixel of panoramic camera. The operation of scanning process is conducted by use main road inside the study area at constant speed to ensure the laser radiation hits entire structural of objects. However, there are area or part that the MLS system cannot access due to very limited space such as the area between building's gaps. Thus, Backpack LiDAR is used to collect point cloud data in this area. Backpack LiDAR is conceptually similar to MLS, but it uses human operator as platform to carry the LiDAR sensor at the back. This system also includes a 12-megapixel panoramic camera for the same function. In addition to cloud point data, it is necessary to establish control points for use in geometric rectification and accuracy assessment. Ground control points (GCPs) and checkpoints (CPs) are the two sorts of control points used, and both are established using the rapid static method. This method can produce coordinate information including Northing, Easting and Elevation after post-processing with the Trimble Total Control (TTC) software, which provides an accuracy of 1 to 10 centimetres. Then these coordinates were converted to X, Y (planimetry) and Z(height). Establishing GCPs is crucial for sustaining the

precision and accuracy of final outputs. There are 20 control points, of which 10 GCPs were utilized for geometric rectification and the other 10 CPs for accuracy assessment. Figure 7 depicts the distribution of GCPs, and CPs measured using the study area's rapid static technique. Each point was observed from 35 minutes to 45 minutes and the height instrument at each point was measured. Theoretically, longer observation can produce a more accurate result. In this study, 35 to 45 minutes of observation is enough for GPS observation because the location of each point is quite close to one another. The target made of plastic with dimensions of 1 meter length and 1-meter width is used as a marker to represent GCPs and CPs on the digital orthophoto. The X symbol is printed on the top of the target to make sure the centre of the target is easily identified on the image during geometric rectification and accuracy assessment.

Figure 7 shows the distribution of GCPs and CPs

DATA PROCESSING

RiEGL RiSCAN Pro software was utilised for processing points cloud acquired from UAV LiDAR and MLS LiDAR systems. Several steps are involved, including filtration, geometric correction, colouring, and exporting. During the filtering step, any noise or error was removed. This elimination approach was accomplished in two ways: automatically and manually.

Following the completion of the filtering procedure, the cloud points must undergo a geometric correction using the GCPs established in the study area. Then, the corrected point cloud was projected into the UTM Zone 48 N coordinate system. To colourise every point cloud, aerial photographs obtained with a digital camera and a 360-degree camera were used as a reference. The point cloud was then exported in LiDAR's standard format, LAS. Figure 6 shows the flow chart of point cloud processing using RiEGL RiSCAN PRO software. This RiEGL RiSCAN Pro software is limited only to pre-processing steps, as depicted in Figure 6. For the post-processing part, LiDAR 360 software was utilized for merging, classification, and export. In the merging stage, UAV LiDAR's point clouds were combined with MSL LiDAR's point clouds to construct a 3D model with a complete structure. Then, these point clouds were classified into three classes, including ground, tree, and building. This classification step was completed automatically by configuring the necessary parameters as indicated in Figure 8. In the final phase, only the building's class was exported as a 3D model. The flow of post-processing is shown in Figure 9.
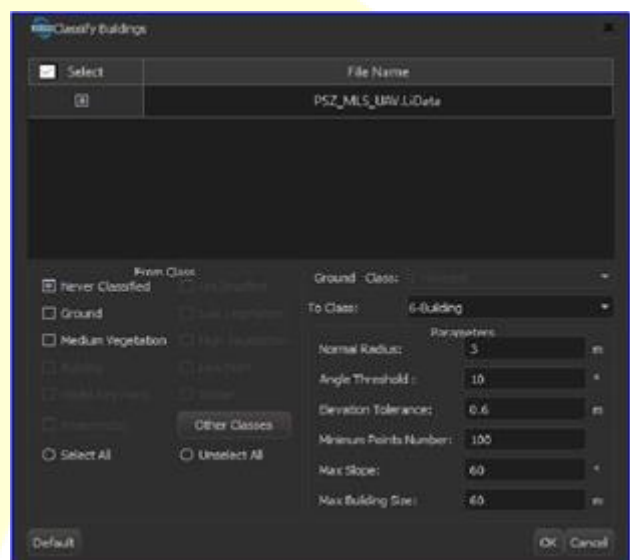
Figure 8 show list of Parameters need to set in the automatic classification step.

Figure 9 show flow chart of post-processing LiDAR360.

For fusion these three set the different data, the transformation method was used to fuse the dense point cloud data of UAV-based LiDAR and MLS LiDAR system. This method is available in the LiDAR360 where the data are rectified based on homologous points visible on all data sets. To merge the data, cubic polynomial technique was used because the number of homologous points is greater than ten. For accuracy assessment, statistical approaches were used to evaluate the quality of the final output. In this case study, the evaluation only considers quantitative analysis. The Root Mean Squared Error (RMSE) equation was used, and it is shown in equation 2 and equation 3. This equation can be defined as the standard deviation of the residuals or prediction errors (Chai and Draxler, 2014). Residuals are a measure of how far from the regression line data points. It is a measure of how to spread out these residuals. This equation is commonly used for evaluating the quality of photogrammetry products including 3D models (Tahar, 2015; Udin et al., 2012).

Equation 2 was used to evaluate the accuracy from a planimetry perspective, while equation 3 was used to evaluate the accuracy from a height perspective. To perform this accuracy assessment, 10 CPs were used, and the result is shown in Tables 1 and 2.

$$\text{RMSE (X, Y)} = \pm \sqrt{\sum \frac{(X-x)^2 + (Y-y)^2}{N}} \quad ..... \text{(Eq2)}$$

$$\text{RMSE (Z)} = \pm \sqrt{\sum \frac{(Z-z)^2}{N}} \quad ..... \text{(Eq3)}$$

Where,
X, Y= Planimetry coordinate observed on the ground (m)

Z= Height coordinate observed on the ground (m)
x, y= Planimetry coordinate on the model (m)
z= Height value on the model (m).
N= Number of check point

RESULT AND DISCUSSION

The primary output of this case study consists of three-dimensional point cloud data of building within the study area's boundary. In general, this three- dimensional model of a features is an outcome of integrating point cloud data from three different LiDAR platforms. This distribution of point cloud data contains feature's information such as faculties, mosque, library, gazebo, cafeteria, tree, slope area, road, and terrain. Figure 10 and Figure 11 show the distribution of point cloud data collected from UAV LiDAR and MLS LiDAR system respectively. Meanwhile, Figure 13=2 shows some of the point cloud data collected from Backpack LiDAR system. This is because the data collection approach for Backpack LiDAR are totally different from the others, where the scanning process is conducted by scanning each building individually or one by one.
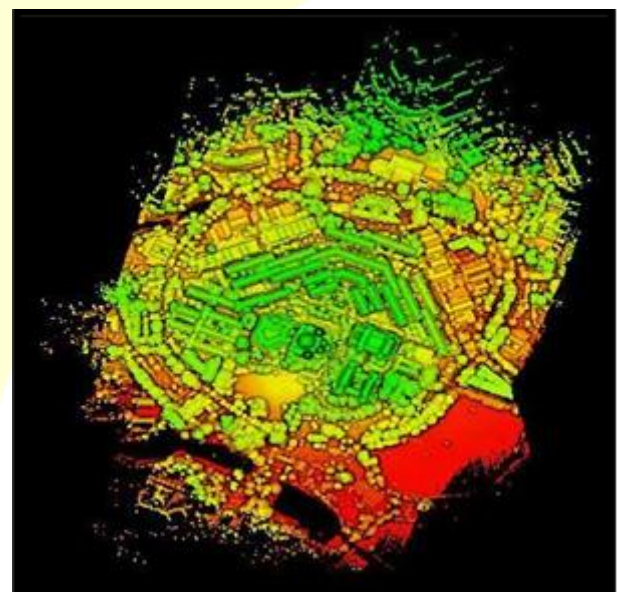
Figure 10 show the point cloud of UAV LiDAR System
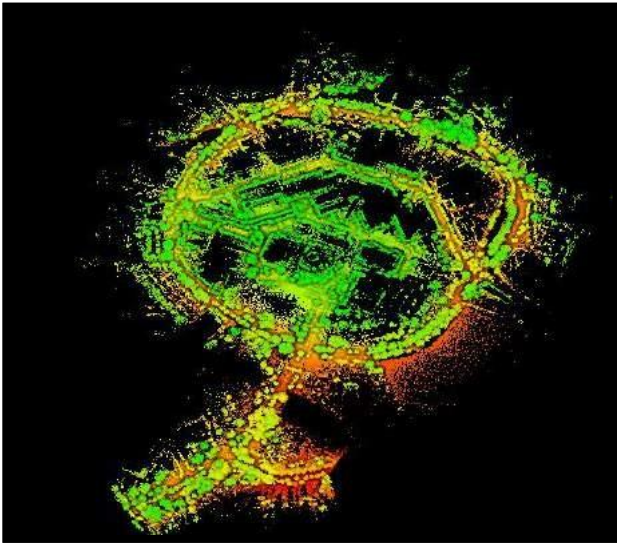
Figure 11 show the point cloud of MLS LiDAR System
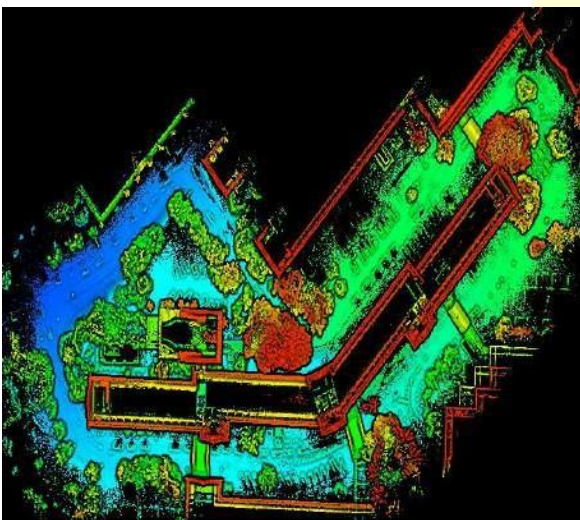
Figure 12 show the point cloud data of BackPack LiDAR System

According to Figure 11 and Figure 12, the point cloud was generated by laser scanning utilizing the MLS and Backpack LiDAR system consisting of vertical structures or façade parts of the building. The MLS sensor was installed at a position parallel to the platform, which is in the horizontal position during the scanning. In this configuration, the sensor is more efficiently scanning the vertical structure of the building while mobile. The MLS system utilized in this case study can scan the

features with an angle of 270-degree. Therefore, the system is capable of scanning a lot of features in the prominent area within a second. However, the system is not equipped with a GPS system, which is used for projecting each point cloud onto the local coordinate system. The transformation technique was employed using the UAV LiDAR points cloud as a reference to perform this process. As discussed in the pre-processing section, the geometry of the UAV LiDAR points cloud was corrected using the GPS data. During the transformation step, the cubic polynomial equation and 18 points were used, and the transformation's error was 0.0018 m. The specification of MLS LiDAR and Backpack LiDAR points cloud data is shown in Table 1 and Table 2 respectively.

Table 1 show the description of Point Cloud Data MLS

Specification	Description
System	MLS LiDAR
Total Points	234,699,568
Standard Deviation of Height	8.493m
Standard Deviation of Intensity	4413.447

Table 2 show the description of Point Cloud Data Backpack LiDAR

Specification	Description
System	BackPack LiDAR
Total Points	444,699,568
Standard Deviation of Height	8.493m
Standard Deviation of Intensity	8413.447

Figure 10 depicts the 3D point cloud of the UAV LiDAR system covering the building's roof structure. During data collection, a LiDAR sensor was placed on an octocopter platform with its sensor pointing nadir. It scanned the study area features from an aerial perspective. The specification of the UAV LiDAR point cloud

is shown in Table 3.

Table 3 show the description of Point Cloud Data UAV

Specification	Description
System	UAV LiDAR
Total Points	61,923,198
Standard Deviation of Height	10.745m
Standard Deviation of Intensity	4654.287

In this case study, three types of the system were used for constructing a 3D building model due to the limitations of the systems. As shown in Figure 10, each system cannot scan a whole building's point cloud due to obstacles. Therefore, both point clouds need to fuse to obtain the complete structure of the building. Some of the results are shown in Figure 13 until Figure 15, while Figure 16 shows the fusion point cloud of UAV, MLS and Backpack LiDAR system for the whole area.
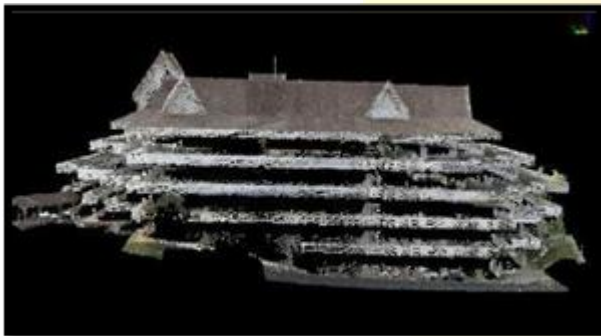
Figure 13 UAV LiDAR Point Cloud of Library

Figure 14 MLS LiDAR Point Cloud of Library
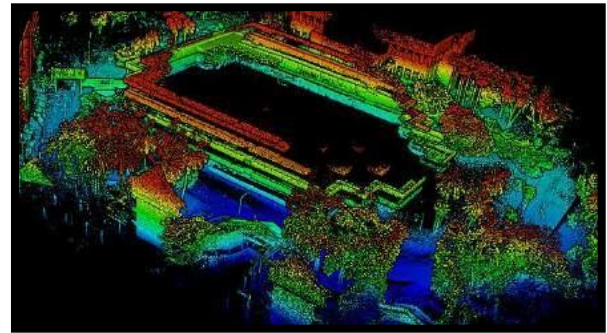
Figure 15 Backpack LiDAR Point Cloud of Library
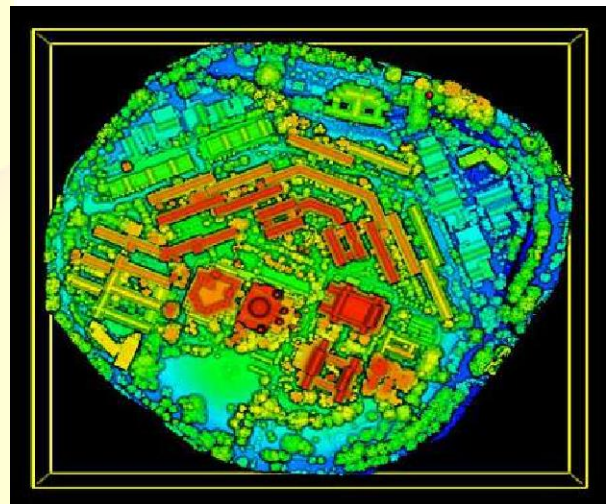
Figure 16 show fused point cloud data.

Accuracy assessment is carried out by comparing the planimetry coordinate on the ground and the planimetry coordinate on the model. Besides that, the model's height was also analyzed by comparing the height value on the ground and the height value on the image. The RMSE of planimetry and height is calculated using equations 1 and 2. Orthophoto and DSM were used to extract the information of planimetry and height coordinates of the model. The RMSE value is shown in Table 3. Based on Table 3, the RMSE value of planimetry is ±0.015 metres, while the RMSE value of Z/height is ±0.009 metres. This result shows that the 3D building model developed from the fusion three LiDAR system is accurate in quantitative assessment. The reason is LiDAR system has advantages compared to other methods for acquiring point cloud data with high accuracy.

Table 4 show RMSE value for quantitative analysis

CP	Different (m)		
	Delta X	Delta Y	Delta Z
CP1	0.015	0.006	0.016
CP2	0.006	-0.004	0.011
CP3	0.009	0.002	-0.005
CP4	0.002	-0.008	0.009
CP5	-0.012	0.012	0.012
CP6	-0.005	-0.003	-0.008
CP9	0.008	-0.004	0.008
CP10	-0.007	-0.004	-0.004
RMSE	Planimetry = ±0.015		Z = ±0.009

CONCLUSION

An approach that fuses point cloud data from multiple sensors can develop a complete 3D building model, especially in an area with numerous objects nearby. In this case study, the aim is to construct a complete 3D building model was achieved. The 3D model has high accuracy at the centimetre level. However, the analysis should be investigate in various method or approach such as comparison the dimension of building between measurement on the field and model.

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URBAN & REGIONAL PLANNING

LIVEABLE NEIGHBOURHOOD: PERSPECTIVE OF ATTRIBUTE IN URBAN PLANNING

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ABSTRACT

Previously, the existing literature indicated several attributes and framework in understanding liveability. Neighbourhoods are a crucial part in creating liveable cities and many studies refer to the measurement and tools for liveable cities and neighbourhoods. However, the emphasis in these tools is arguably not able to capture the community perspective of culture and lifestyle despite it being important in urban and city planning. Thus, this paper is to review the existing literature on the current approach and debate the community perspective in liveable neighbourhoods. The issue raised from the argument is how the community perspective at neighbourhood level in the existing literature is incorporated into a liveable index. Therefore, the aim is to understand the liveable factors on township and neighbourhood development and the conceptual framework applied in the literature in order to put the context for Malaysia. The expectation of the paper will highlight the attributes of liveable view from the community neighbourhood that might be concerned in the framework and model on liveable and neighbourhood. The highlight is to provide a better grasp on the community's actual needs and standards associated with cultures and lifestyles of liveable neighbourhoods.

Keywords: Liveability, Neighbourhood, Cultural, Community Planning

INTRODUCTION

Community is a basic unit of neighbourhood. Neighbourhood and community are interrelated with each other in a development planning. Neighbourhood mostly refers to the area associated with adjacent to or around a city. The community is defined as a group of people who live in a certain neighbourhood or area. Community perspective preference is important as what they want in their neighbourhood and lifestyle. As population expands and the need for sustainable development increases, the liveability of the city is the

key concern in this context.

The vast majority of liveable studies fall under two scopes which are development policy and measurement tools but not much from a community perspective in neighbourhood context. Based on literature studies, the community effect is based on these two scenarios. A neighbourhood must be liveable as it is related to the well-being and quality of life. Liveability encompasses multiple knowledge domains through various perspectives, which includes psychological, social and cultural factors. Therefore liveability can extend beyond concerns with one's physical environment (Leby and Hashim, 2010; Jancsary et al., 2017). Since the term depends on the characteristics and culture of the city, there is no clear definition of what constitutes a liveable city.

The goal of neighbourhood and community based research is to determine the significance of context in people's lives and their living environment (Leby and Hashim, 2010). To incorporate community in city and neighbourhood planning, a number of traditional community engagement techniques have been created, notably public hearing, town hall meetings, focus groups and workshops (Horelli, 2002; Rowe G. and Frewer L., 2005; Sanoff H., 2000). Although many of these approaches do not actually provide inclusive involvement engaging a varied number of community people, they are intended to enable communities to address neighbourhood concerns (Van Asselt, Rijkens N., 2002; Bryson et al., 2013; Levine et al., 2005). The neighbourhood community serves as a both decision-making body and solid framework for expressing the views of the populace and improving overall well-being through time. The neighbourhood community acts as a platform for obtaining more human resources to advance the decision-making process during the various stages and processes of urban development (Abdullah J. et al., 2015). Hence, this research paper is based on

the consideration as to how the concept of liveable is being viewed from the perspective of community within the framework of existing literature on social environment, functional and safety.

METHODOLOGY

Two sets of combined keywords were used in the titles, keywords, and abstracts to locate the research in the Scopus and Web of Science (WoS) databases, which contain a variety of highly regarded journals. Science Direct, a different scholarly database additionally served to make sure that each prospective preceding study had an equal opportunity to be chosen for compilation.

The terms that were searched were chosen in relation to the neighbourhood community and were used as substitutes for phrases like social, physical, safety and function emerging as a new keyword. Therefore, the term was used to locate relevant older research in the contexts of liveable neighbourhoods in the designated database. Additionally, only prior research papers published journals with a focus on the terms 'neighbourhood' and 'liveable' were included in the screening procedure to guarantee the quality of the review. Liveability was a common issue in city development in the 1970s, thus the perspective from community in neighbourhood was limited to study. To date, the community neighbourhood study started to become more prevalent in the 2000s and continued to expand yearly. By determining the geographical scope of the research and the attributes of liveable are engaged in the perspective of community in their neighbourhood. The determination of prior research in connection between community neighbourhood and liveable concept had concluded in the filtration process.

RESULTS

This paper indicates only the perspective of society and their response with the environment. According to previous

authors, living in a city requires navigating an intricate network of social and physical interactions. The importance of quality of living environment would influence community well-being and it is good to overview as to how urban characteristics such as liveable attributes of the neighbourhood will influence community reaction and contribute to local development. Communities have the right to choose the best neighbourhood to live and lifestyle they want. The importance of a person's neighbourhood in determining their quality of life has been highlighted by numerous researchers (Marans & Kweon, 2011; Sirgy & Cornwell, 2002). For instance, environmental psychology that showed the relationship between neighbourhood physical qualities and community wellbeing (Barker, 1968; Führer, 1983; Guite, Clark, & Ackrill, 2006; Stokols, 1982; Wicker, 1972).

ATTRIBUTE OF LIVEABLE NEIGHBOURHOOD

Neighbourhoods have long been a crucial planning and critical area for a city. Numerous studies have been conducted on the influence of a neighbourhood on a resident's life (Myers, 1987; Omuta, 1988; Veenhoven, 1996; Lee, 2005), using a variety of terminologies to describe what is meant by quality of life. Liveability is one of the concepts that is frequently utilized related to quality of life. It is a concept that develops from how a society and its surroundings interact (Shafer *et al.*, 2000). Essentially, it relies on a subjective assessment of the community's attitudes towards their neighbourhood space. There are many attributes that are discussed by researchers to achieve liveability in urban areas as mentioned in Table 1. As stated by Van Kamp *et al.* (2003) and Pacione (2003), the attributes selected will usually rely on the field of study, cultural backgrounds, and goals of the researchers.

Table 1 Attribute of liveable on previous research

Author	Year	Attribute of Liveable
Doolittle and Macdonald	1978	Population Local Preference Safety and Security Social Interaction
McMilan and Chavis	1986	Sense of Belonging Expectation and Satisfaction
Chavis and Wandersman	1990	Expectation and Satisfaction Social Interaction
Bishop	1995	Access and Mobility Infrastructure and Facilities Public Amenities Economy of the City Living Quality Safety and Security Social Interaction
Lynch	1998	Access and Mobility Sense of Place Expectation and Satisfaction Infrastructure and Facilities Living Quality

Omuta	1998	Infrastructure and Facilities Public Amenities Job Securities Economy of the City Affordable Housing
Talen	1999	Population Local Preference Safety and Security Social Interaction
Tonnies	2001	Population Local Preference Safety and Security Social Interaction
Wheeler	2001	Access and Mobility Public Amenities Affordable Housing Safety and Security
Holt-Jensen	2001	Infrastructure and Facilities Function of the City Social Interaction
Perkin and Long	2002	Safety and Security
Vergunst	2003	Expectation and Satisfaction Public Amenities Economy of the City Physical Setting Local Preference
Pacione	2003	Expectation and Satisfaction Infrastructure and Facilities Function of the City
Balsas	2004	Access and Mobility Sense of Belonging Infrastructure and Facilities Function of the City Economy of the City Safety and Security
Throsby	2005	Sense of Place Infrastructure and Facilities Public Amenities Social Interaction
Visser *et al.*	2005	Function of the City Affordable Housing Social Interaction
Heylen	2006	Living Quality Physical Setting Safety and Security Social Interaction
Howley	2009	Access and Mobility Infrastructure and Facilities Public Amenities Economy of the City Living Quality Safety and Security

		Social Interaction
Jasmin LL and Ahmad HH	2010	Function of the City Physical Setting Safety and Security Social Interaction
Litman	2011	Public Amenities Economy of the City Social Interaction
Barth	2011	Living Quality
Elvas and Moniz	2012	Expectation and Satisfaction Infrastructure and Facilities
Castillo *et al.*	2016	Social Interaction
Khorasani and Zarghamfard	2018	Social Interaction

Based on these, it shows four (4) categories which are social environment, physical environment, safety environment and functional environment. This category tracks connections of numerous social components. The majority of the research mentioned and concentrated on attributes of social interaction and community lifestyle. Another issue is the behaviour of the neighbours, but in Omuta's study, it is treated as a different component. The sense of place that community has, which has been linked to contentment in studies, is another factor that could be taken into consideration. In addition, moral support from neighbours and friends (Dasimah *et al.,* 2005), relationships with neighbours and mutual and self-help (Nurizan *et al.,* 2004) are a few social variables that are examined in fulfilment studies in urban settings.

Initially, the physical environment is the setting in which communities live, work and form a social interaction. Community utilise, engage with, and actively use the area, as well as observe it. Despite being outside influences, the area's physical features can affect how people view and feel in either a good or bad way. The natural environment of communities is emphasised in the majority of research, which increases awareness of the quantity and variety of greenbelts and parks in a neighbourhood community. It also includes building upkeep and environmental factors like noise, pollution, litter, and congestion. Heylen (2006) mentioned the provision of amenities and services under these categories while Omuta (1998) tended to split them. Nevertheless, it considered that this attributes should be added to the functional category in accordance with how the majority of the research analysed the categories. Similarly, as observed in Malaysian, certain physical and functional indicators were given different labels and categorised under the term of social and public facilities (Osman *et al.*, 2004; Nurizan *et al.*, 2004). Despite the fact that other living conditions are excellent, a high crime region cannot be transformed into one with a great quality of life. According to Savasdisara's (1998) study, security and safety are the key attributes in predicting satisfaction with overall living circumstances in Japanese metropolitan areas.

The functional environment category indicates the important attributes of access and mobility such as access to and location of stores, kindergartens, shopping malls, clinics, schools, and other facilities to determine well-being (Holt-Jensen, 2001). When communities assess the quality of life in their neighbourhood, the private and public service provision is significant. Accessibility is seen to be a key element in this category. Job security is another most significant attributes that improves the quality of life from an economic standpoint considering it serves as a source of income and economic

foundation. Thus, job opportunities are a crucial way for people to form social connections and participate in communal activities, even though few researchers use it as an attribute.

Afterall, the influence on neighbourhood communities is caused by their physical environment, social environment, safety environment and functional environment. In fact, it has been emphasised that local involvement affects the developed environment's quality and the urban area's development, particularly in the housing area. The liveability involves the quality of community life towards housing and urban characteristics (Werner, 2005). It becomes more challenging to overlook the perspective of liveability due to the dynamic urbanisation trend. It captures the lived-in experiences of residents, the liveable neighbourhood is essential to the profitability and expansion of cities.

LIVEABLE NEIGHBOURHOOD ON COMMUNITY PERSPECTIVE

Based on Table 2, the preferable attributes in a neighbourhood are (1) community engagement, (2) safety, (3) physical and mental health, (4) retail and services, (5) education, (6) employment, (7) physical and social activities, (8) quality of life and (9) walkability.

Table 2. Community perspective in neighbourhood

Author	Year	Community's Perspective
Leventhal and Brooks-Gunn's	2000	Neighbourhood pollution
Small and Newman	2001	Community environment
Wang and Lee	2010	Physical Activities and Walking
McCormack *et al.*	2010	Social Activities
Levasseur *et al.*	2015	Social Relationships
Van den Berg *et al.*	2015	Quality of Life
Liu *et al.*	2017	Physical and Mental Health
Lee and Tan	2019	
Dasimah *et al.*	2016	Social Interaction (Youth Participant)
Luca Bottini	2018	Community Participant
Emily Walton	2018	Mental Health
Sinan Zhong and Chanam Lee	2022	Housing Safe Neighbourhood Health and Supportive Services General Retail and Services Social Integration Education and Employment
Saeed Ahmadi Oloonabadi and Perver Baran	2023	Neighbourhood Walkability
Charlotte *et al.*	2023	Neighbourhood Safety Physical Activity Mental Health

The study of urban areas and social issues has become more relevant in urban research, the relationship between community engagement and the urban environment has not been adequately explored (Francis, Giles-Corti, Wood, & Knuiman, 2012; Gans, 2002; Gieryn, 2000; Hillier, 2008; Logan, 2012; Simpson, 2011; Tonnelat, 2004). It has a variety of social programmes like weekly community

art workshops events, community members with a charity program such as a central plaza and a community park that can help people of all ages form social relationships (Henkin and Patterson, 2020). Many authors stressed the value of physical surroundings for promoting walking and other forms of exercise, social interactions, quality of life, and community members' physical and mental health (Lee and Tan (2019); Levasseur *et al.* (2015); Liu *et al.* (2017); McCormack *et al.* (2010); van den Berg *et al.* (2015); Wang and Lee (2010). Recently Zhong et al., 2020, Zhong et al., 2022; Zhong, 2020). Zhong *et. al* (2020) carried out a research investigation as one of the earliest initiatives to link community settings with cross-generational activities. The result of the investigation showed that older persons' relationships with other generations and their peers' community in the neighbourhood were highly influenced by their neighbourhood surroundings (such as land use and transportation). It also implied that intergenerational interactions between older persons and their community are subject to diverse environmental facilitators and barriers. This also shows the physical environment is one of the important attributes in liveability. It is essential to provide secure, accessible by foot, lovely, and socially inclusive neighbourhood surroundings in order to promote older folks' social and physical engagement and support individuals as they age in place (Forsyth *et al.*, 2019; Keskinen *et al.*, 2018; Moran *et al.*, 2014). Due to the older adults utilising the majority of their time in the homes and neighbourhood and concern about the neighbourhood's safety at the same time. Liveable attributes such as housing, a safe neighbourhood, health and additional services, products and services, social inclusion, education and jobs are all discussed in Generation United report (2016).

Initially, the community was very critical of the perspectives that claim the neighbourhood effects are creation based on personal characteristics such as wealth and desire (Galster and Sharkey, 2017). Additionally, the concept of neighbourhood effects on health has been discredited using environmentally influenced designs (Sariaslan *et al.*, 2016). Likewise, the neighbourhood design affects walking behaviour (Giles-Corti *et al.*, 2010; Van Dyck *et al.*, 2009) and walking is part of physical activity (Kelly *et al.*, 2007) that has significant health advantages (Day *et al.,* 2006). Following the pandemic, emphasis is now being paid to topics like mental health. The model of enhancing health is a good illustration of the influence of complex individual, interpersonal, and physical environment-related elements on medical outcomes. (McLeroy *et al.,* 1988). Additionally, it highlights the constant interactions between communities and their surroundings (Stokols, 1996). The importance of social and physical settings in promoting and preserving general well-being in community (elderly) was highlighted by Lawton's person-environment fit theory (Lawton, 1983).

Within this context, physical activity has several recognised health advantages. Daily physical activity is associated with enhanced physical activity, psychological well-being and a healthy weight status in the community (Kumar *et al.,* 2015). Essentially, a crucial setting for physical exercise during childhood is the neighbourhood environment. In addition, a perceived risk to individual safety can prevent people from engaging in physical activity if they feel insecure in their neighbourhood. A psychological reaction or sentiments of worry towards criminals or signs associated with violence can be characterised as fear of crime (Ferraro, 1996). Insecure neighbourhoods and elevated fear of crime can result from anti-social behaviour and public disorder offences (Brunton-Smith and Sturgis, 2011; Office for National Statistics, 2022).

In order to create a liveable neighbourhood with a high-quality living environment, the concept of a

neighbourhood involves examining the differences among the individuals who live in and share the same area. A set of neighbours that are able to communicate, look out for one another, and work together consistently is required. A factor showing general human connection in the neighbourhood unit is community engagement (Okunola and Amole, 2012). As a result, everyone should actively participate, not only the elderly but the youth should widen their social circle, and execute this project to make a healthy living neighbourhood. Young people dominate and are the most active demographic in the neighbourhood. Since they play an important role in determining the community's well-being and preserving our culture for the long term, they normally participate in and attend community programmes and events. Youth today are more interested in material possessions and materialism than cultural values (Raba'ah, S. H. *et al.,* 2014). Engagement in the community is a way to improve knowledge on how to live life to its fullest and should not be limited (Chamhuri, N.H. et al., 2015). Neighbourhood is a more pleasant and harmonious place to live, inhabitants once community actively communicate their needs, desires, and opinions (Wattanasin, S., 2015). In light of these demands, Shuib, K.B. *et al.* (2015) argue that involvement in urban space concerns, such as neighbourhood community, is essential to bringing efficiency advantages to the immediate area. Additionally, taking part in community activities offers high levels of safety to residents and helps us build positive relationships with others who live nearby, which keeps the community peaceful and liveable Amir, A.L. *et al.,* 2015).

Other researchers have attempted to go beyond a simple analysis of the factors by concentrating on the unique qualities of the area, like in the case of Leventhal and Brooks-Gunn's (2000) study on how local pollution affects youth communities. However, Small and Newman (2001) stressed the importance of the family

setting in influencing how young communities develop. The correlation between inhabitants' susceptibility and their continuous exposure to the area is currently the subject of neighbourhood impact studies (Galster, 2012; Harding, Gennetian, Winship, *et al.,* 2011; Small & Feldman, 2012). Another section of the literature discusses the idea of participation, in which communities impulsively start doing things for their local area. According to Cuba & Hummon (1993) and Ley (1973), the term 'community participation' is a concept used to describe a type of interpersonal communication that happens in neighbourhoods communities. The terms 'civic engagement' (Atkins, 2016; Boulianne and Brailey, 2014; Schofer and Fourcade-Gourinchas, 2001; Youniss, 2009) and 'civic participation' (Kang and Kwak, 2003), as well as 'citizen participation' (Goodspeed, 2008), also refer to the same idea. Additionally Abrams (1970), emphasised the idea of community participation with residents actively participating in improving programmes that directly affect their neighbourhood. Community participation, according to Hamdi (1995), refers to procedures where specialists, households, communities, government and other expertise work together for a shared objective, ideally in both formal and casual settings. Here, participation is viewed as what a person can do and what they do to improve the neighbourhood while achieving the liveable neighbourhood.

The existing frameworks offer insight covering the domains of social environments (such as community engagement, physical and social activities), physical environments (such as quality of life, education, employment, retail and services) and safety environment (such as safety, walkability, physical and mental health). The need to liveable in this context is constructed from the perspective of people living as discussed in the literature.

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As discussed, the basic neighbourhood qualities concerning the community involve nine (9) attributes. These attributes would encourage neighbourhood to a liveable and healthy space and would encourage elderly and youth people to become involved in community life. The attributes covers harmony, respect, a sense of family and neighbours, along with cooperative, companion, cultural, and ethnic values. Consequently, one of the most significant elements influencing consumer decisions and estate selection is the neighbourhood environment [83] the element of a residential setting that can meet the needs of neighbourhood community on a daily basis. The issue lies on the most influential attributes and what to study in depth with consideration that there many attributes need to be taken into account in order to comprehend the function of the city for quality of life in their neighbourhood.
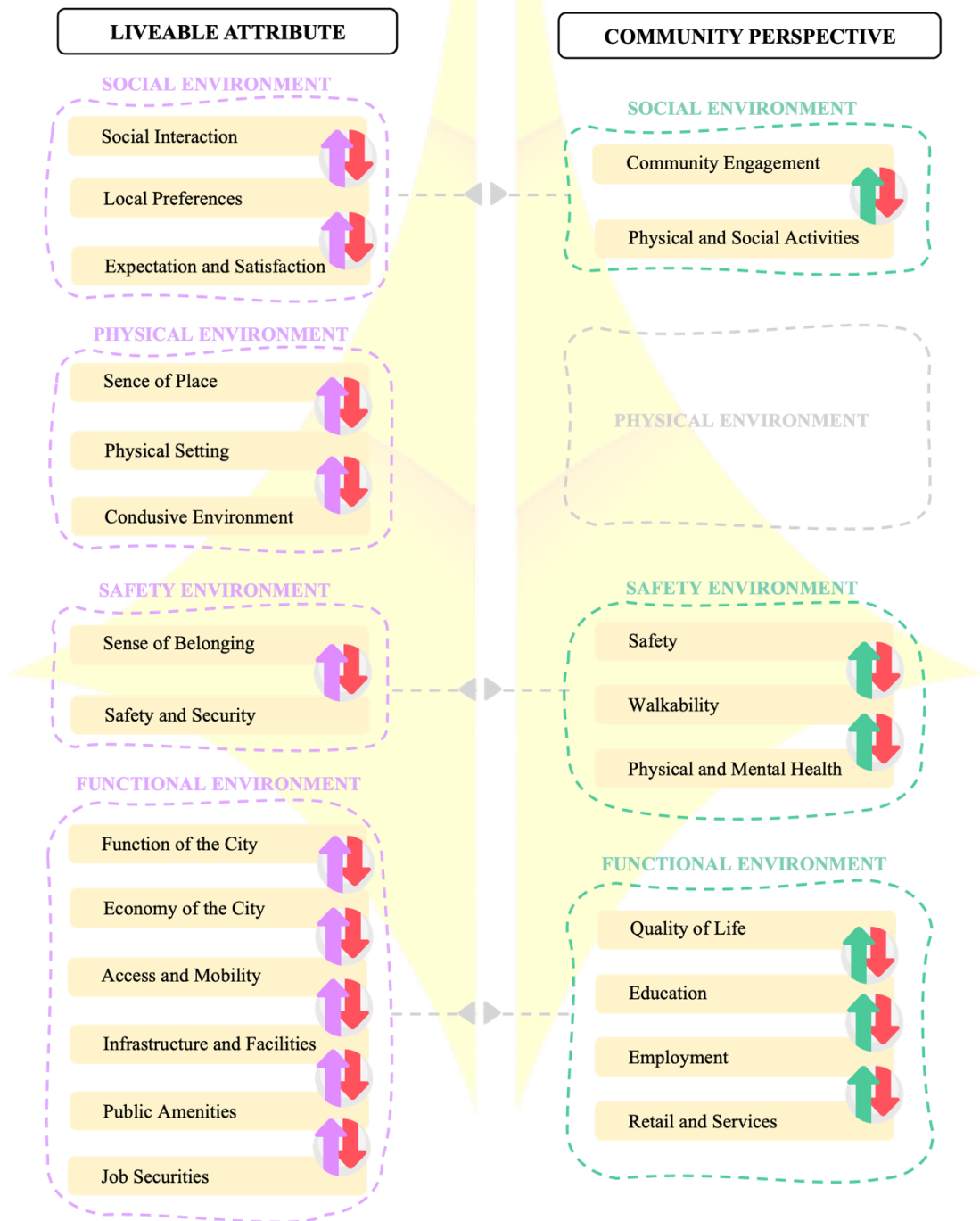
Figure 1 Attributes of liveability

CONCLUSION

Therefore, it is essential for urban planners to consider the factors that are critical for allowing people to live with good quality and offered living experiences. There are nine (9) community perspectives listed as the liveable neighbourhood attributes. These nine (9) perspectives would encourage the development of a pleasant neighbourhood community. By accentuating the nature of society, these neighbourhood features should be regarded as the good practise and attained through cultural and lifestyle values. To create a role model, cultural and lifestyle values must be included in the neighbourhood community context.

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URBAN TRANSPORT INTERVENTIONS: WAY FORWARD TO RESILIENT CITY, CONTEXT OF LAHORE, PAKISTAN

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ABSTRACT

Urban transportation is vital for the proper functioning of cities, as millions of trips are made daily for education, work, shopping, leisure, etc. The transport industry is one of the few sectors where emissions are continuously increasing. So, it's the basic reason for increasing interest in climate change, particularly in the field of transportation. In the context of Pakistan, a 44% increase in per capita emissions has been recorded during 2013-2018. The major contributor to the emissions is the frequent use of private vehicles, particularly cars. 3.99 million vehicles have been registered in Lahore during the past decade. Transport agencies everywhere in the world are focusing on mitigation strategies to reduce greenhouse gas emissions. Transport Policy-makers are striving hard to develop such policies for achieving a resilient transport system. There is an urgent need to develop transport infrastructure that can absorb, recover and prepare for any interruption, either natural or man-made. This research attempts to explore the urban transport policies and interventions developed by the Government of Pakistan for achieving resiliency in transportation, particularly in the context of Lahore, Punjab. The primary focus of the research was the secondary data regarding transportation policies and environment-friendly transportation projects executed in Lahore. To conclude, stabilization in emissions from the transport sector can be achieved through, behavioral change that needs to be brought into policy will also be required. Additionally, guidelines and strategies need to be proposed for every objective of the policy.

Keywords: Resilient City, Climatic change, Transport Policy, Behavioural changes

INTRODUCTION

Urbanization is a key issue in the economic development of cities, regions, and even countries. City areas cover only 3% of the earth's land but their contribution to the Gross Domestic Product (GDP) is 80% (Gao and Zhu 2022). Urbanization has led to a change in the mobility pattern, more dependency on private automobiles (particularly car-based mobility) adding more traffic on the road, creating various problems including congestion, noise, accidents, and pollution. Urban mobility is vital for the proper functioning of cities, as millions of trips are made daily for education, work, shopping, leisure, etc. (Gonçalves and Ribeiro 2020). The transport industry is one of the few sectors where the emissions are continuously increasing and causing severe climate changes, as a consequence, transport infrastructure is more susceptible to risk which sequentially renders vulnerable cities (Azolin, Rodrigues da Silva, and Pinto 2020).

The transportation system is one of the critical infrastructures and is considered as backbones of any society for the development and economic growth of a nation that is under continuous threat due to climate change. Owing to the key role of the transportation system in ensuring the economic stability & growth of a nation, it is important to anticipate the impacts of climate change on the transportation system and prepare for it in time. Furthermore, the negative effects of climate change on the transportation sector disproportionally affect developing countries. Consequently, these need to adapt to unavoidable risks posed by climate change in a planned, structured, and coherent methodological approach focusing on such arrays of measures and policies that can effectively and efficiently deal with climatic impacts (Vajjarapu, Verma, and Gulzar 2019).

Pakistan has been continuously ranked among the most affected countries by climate change in the long-term Global Climate Risk Index (GCRI) and the GCRI for the respective year. Pakistan ranked 5th among the 10 most vulnerable economies to climate change in the last two decades, with an average Climate Risk Index (CRI) score of 28.83 between 1998–2019 (Ahmed et al. 2020). The total number of vehicles on roads in Pakistan is 19.09 million of which 2.99 million are cars (Naveed Arshad 2019). There are three categories of vehicles used i.e., motorcycle/scooter (bike), light commercial vehicles (LCV), and heavy commercial vehicles (HCV). Due to an inadequate supply of public transport facilities, the number of private vehicles of different types has increased in the range of 928% (motorcycles/scooters) in 2000-01 to 64% in heavy commercial vehicles (HCV) in (2019-2020) (Abedullah 2021). This shows an inadequate supply of public transport facilities. The only option available for people is to use their vehicle, either bike or LCV, which is the reason for the highest increase in no. of bikes followed by LCV (725%) during the last 20 years. The total number of vehicles is estimated to reach 31.8 million by 2025 with 4.11 million cars only (Abedullah 2021; Nadeem Ul Haque Muhammad Rizwan 2020; Naveed Arshad 2019).

This drastic increase in bikes and LCVs has led to an increase the environmental pollution. The average emission of CO_2 by a petrol-used car is 180 grams/km. On the other hand, CO_2 emissions released by a bus are 650 grams/ km. On average, two persons per car normally travel in Pakistan. If these people travel by bus they can replace 40 cars with one bus which causes pollution equal to 3.6 cars only. This implies that a bus can reduce CO_2 equivalent to 6.5kg/km. Thus, only replacing cars with buses, can have a positive impact on the reduction of CO_2. If an attempt to replace the car with an eco-friendly mode of transport, an average of 15-20 bicycles can be operated. A bus with about 80–100 passengers takes the space of about 3 cars only while it can

replace about 25-30 cars (Abedullah 2021).

The upshot of the above discussion is that by just provisioning efficient public transport, a prominent reduction in carbon footprints can be witnessed and serve as a catalyst for accomplishing Sustainable Development Goals (SDGs). Urban transport interventions for instance mass transit projects and emission-free automobiles can prove to way forward for resilient transport (Abedullah 2021; Ahmed et al. 2020). The core research questions of this review are as follows: (a) What are the recent plan/policy in transportation for the realization of the resilient transport sector in Pakistan? (b) What are the urban transportation interventions for achieving the target of resilient transport in Lahore, Pakistan?

RESEARCH METHODOLOGY

To answer the above research questions, and to present a review of transport plans and policies focusing on resilience, a systematic process was adopted that means analyzing, evaluating, and interpreting the existing literature to conduct a comprehensive review based on the secondary data available. The process comprises three steps such as database searching (online and gray literature), screening, refining, and analyzing. Existing literature and documents related to each specific research question have been evaluated. Both published and grey literature were reviewed and analyzed in the study. Since the independence of Pakistan, there were numerous plans and policies developed in the context of transportation. This study reviewed national plans and policies developed particularly in Lahore, such as the Master plan, and transport plans. The concept of resilience emerged in 1970, which is the primary focus of research. Thus the research focuses on the Transport Policies which incorporated the concept of resiliency. It also includes Vision 2025, National Climate Change Policy 2012 & 2021, however, for the review transport section of climate change policy is considered. The rest of the chapters and sections were excluded. Grey literature on the other hand refers to unpublished reports, dissertations, and abstracts that were also included with great care.

RESILIENCE OF TRANSPORTATION SYSTEM

The term resilience was initially developed in human psychology and was considered a human trait to recover from illness, depression, or any other misfortune incident that happens in life (David Fletcher 2018). However, in modern sciences, it was first used in ecology in 1973 by C.S Holling, as the ability of a system to tolerate disruption under critical conditions and cope successfully (Gu et al. 2020; Pan et al. 2021; Zhou, Wang, and Yang 2019). Resilience in the context of transportation is the capability of a system to maintain its operation or recover/restore itself within a timeframe, or simply it can be the ability of a system to minimize operational loss. Therefore, the term resiliency is often synonymous in the literature with robustness, reliability, redundancy, fault tolerance, survivability, and adaptability or vulnerability (Ganin et al. 2017; Woods 2015). The significance of resilience in the transport sector has been increasing due to climatic changes causing catastrophe incidents. Thus it has gained the attention of researchers and transport policymakers (Erik and Lars-Göran 2021; Xianbo Zhao, Yongjin Ke, Jian Zuo, Wei Xiong 2020). Climatic impacts have been observed in both developed and developing countries differently. In 2021, record-breaking heatwaves were observed in North America and Southern Europe, and severe storms also hit Europe throughout July, causing flooding, Wildfires were witnessed in California, Australia, Turkey, and Greece. Many countries in Africa, and Asia have observed increased rainfall from landfall cyclones, shifts and extensions in

monsoon seasons, and unpredictable extreme rainfall. All of these have direct impacts on the transport industry either in the form of deterioration and erosion of infrastructure or loss of services (Greenham, S., Workman, R., Ferranti, E., McPherson, K., Quinn, A., Street, R., Dora, J., Fisher, R., Mills, S., Packham, K., Baxter, W., Roberts 2022).

Public transit has been affected by numerous cataphoric events such as a minor disruption in Singapore's metro network in December 2011, a signal failure in the metro line of Shanghai, China, in September 2011, and a collision of a metro train with an empty train which was passing in Kuala Lumpur, Malaysia on May 2021. Transportation systems consisting of rail and light rail, urban rail transit is playing an integral part in the daily movement of people. These above-referred incidents such as train breakdowns, electrical failures, and communication system breakdowns have resulted in the delay and cancellation of thousands of trips as well as economic and opportunity losses. Even limited-service disruptions in metro systems could result in significant productivity loss and widespread confusion, the example of Singapore (Jin et al. 2014; Wikipedia 2021a; Zhang et al. 2018). Thus, to improve or achieve resilience in transport, careful assessment is required to ensure that the right method is adopted since the capabilities of the system and operators do vary as per the circumstance (Greenham, S., Workman, R., Ferranti, E., McPherson, K., Quinn, A., Street, R., Dora, J., Fisher, R., Mills, S., Packham, K., Baxter, W., Roberts 2022)

REVIEW OF NATIONAL TRANSPORT POLICIES

This section discusses and highlights the transport plan and policies. It has been divided into two parts. Part one discusses the Sustainable Transport Policies and part two discusses the Resilient Policies. Although resiliency has been introduced in 1970, in the context of Lahore, Pakistan, it was adopted at the start of the 21st century.

Sustainable Lahore Transport

The first effort in the urban development of Lahore was in the form of a Master Plan for Greater Lahore(1965-1980). Under the transportation head, it has proposed the construction of new roads, bridges, grade-separated junctions over railway crossings, Ring Road, a new road bridge over the River Ravi, multi-story parking lots in the central area, etc. It was suggested in the plan to use the railway system as a mass transit system. This was the start of a new development era in the city. Lahore Urban Development and Traffic Study (LUDTS-1980) was the second effort for the development of the traffic system. It also emphasizes the development of Ring Road. None of these plans worked out for the establishment of the public transportation system. In the early 1980s Transport Corporation was established to organize bus-based public transport in the city under Punjab Urban Development Project. This was the first initiative for public transportation in the form of a bus system (Imran 2010).

Later on, several comprehensive studies were conducted on transportation in post-1990 which were funded by the Japan International Cooperation. The study recommended grade-separated road infrastructure at various junctions, a series of semi and complete ring roads, and a public transport system based on light-rail transit. Later, Later, in 1997 the Punjab provincial government initiated a 'Lahore Roads Rehabilitation Project', the main focus was on the remodeling of primary roads and the provision of grade-separated underpasses and overhead bridges on railway links. In 1998, 'Urban Public Transport Policy was introduced which emphasized the need for bus-based public transport, though the condition of public transport has been improved slightly in Lahore. The Integrated Master Plan for Lahore is an urban development plan prepared to guide developments from

2001 to 2021. wherein 5% of funds were allocated for public transport whereas the rest of 95% was for road improvement. (Ahmed et al. 2020; Imran 2010)

Resilient Lahore Transport
Vision 2025

Vision 2025 is one of the primary planning documents issued by the Government of Pakistan (GOP) in 2014 to achieve 25 visionary goals by 2025. It is a living document to be reviewed every three years. For the understanding and realization of national goals, the seven core areas have been identified and linked with one or more relevant SDGs. Vision 2025 has acknowledged and enlisted measures for the development of urban and rural areas and the country as a whole. Each core area is considered a pillar and transportation falls under Pillar 7 i.e., Modernizing Transportation Infrastructure & Greater Regional Connectivity, and was linked to SDG-9. The government has acknowledged that the lack of transportation infrastructure is a major constraint in economic growth and estimated a loss of 4-6% of GDP due to an in-efficient transport system. To overcome this loss, the government has planned to increase road density from 32 km/100 km^2 to 64 km/ 100 km^2 and share of rail in transport from 4% to 20%. The government has also envisioned promoting mass transit systems and developing means for an eco-friendly mode of transportation (Pakistan 2014). The implementation of this vision is a big challenge, as the document does not provide detailed guidance for it (Abdul and Yu 2020).

Climate Change Policy (GOP)

GOP introduced its first policy regarding climate change in 2012 which has been upgraded in October 2021 to meet the surge of climatic impacts. It has proposed several mitigatory and adaptative measures. To mitigate climatic impacts, the policy has enlisted different ways to limit the emissions from transport, for instance, promoting fuel-efficient public transport, regularization of vehicle emission standards, planning and developing mass transit systems in cities, improving, and upgrading pathways & encouraging eco-friendly modes of transport. The recent addition to policy is the inclusion and approval of the National Electric Vehicles Policy 2020 to combat carbon emissions. This ambitious policy aims to achieve a target of seeing electric vehicles capture 30% of all passenger vehicles by 2030 and 90% by 2040 (Ministry of Climate Change 2012; Pakistan 2021). One of the impeding factors in its execution is the lack of implementation. This challenge has also been endorsed by the ADB in its report on the climate change profile of Pakistan (Abdul and Yu 2020; Qamar Uz Zaman 2017).

National Transport Policy (NTP) 2018

To meet the rising demand for transportation and to provide high-quality transportation, the national transport policy was enacted in 2018. NTP was prepared in line with Vision 2025 aiming to support Pakistan in becoming one of the top 25 global economies by 2025 and the top 10 by 2047. The policy aims to provide safe, affordable, efficient, durable, and environmentally friendly means of transport, ensuring reliable access to jobs, markets, education, and other services for all. The policy is based on 11 principles and 8 objectives (Ministry of Planning 2018).

For the implementation of national policy in letter and spirit, it has been recommended that a Cabinet Committee on Transport shall be constituted by the Prime Minister or Cabinet within 3 months of the approval of this Policy involving all the ministers directly or indirectly related to transport. To review matters regarding policy and project implementation, Cabinet Committee will be convened a minimum of twice a year, or whenever required (Ministry of Planning 2018). As per The News International dated April 24th, 2021, the federal cabinet has constituted a committee on Transport and Logistics (CoTL).

National Electric Vehicle Policy 2019

GOP has introduced the National Electric Vehicle Policy (NEVP) 2019, one of the major milestones toward controlling emissions from the transport sector (Pakistan 2019). The sectoral emission inventory for Punjab shows that 43% of total air pollutant emissions are coming from transport (Food and Agriculture Organization of the United Nations 2020). Since 74% of vehicle share in Pakistan comprise of the motorbike while 13 % is the private car. Private automobiles are increasing drastically and creating air pollution and ultimately causing climate change (Nadeem Ul Haque Muhammad Rizwan 2020). In such circumstances, NEVP is inevitable. The initiation of Electric vehicles (EVs) has a dual benefit, controlling the emission from private automobiles (fossil fuel vehicles) and surging oil imports. The policy objectives include mitigating climatic change through the reduction of emissions, promoting and encouraging industrial growth of EVs and its allied industries, generating green employment opportunities, and reducing oil imports. The document provides policies regarding an incentive for EVs, new cars, two & three-wheeler, buses, and trucks and for setting up EV manufacturing units, charging infrastructure. The government has also decided to establish a National Center for Electric Vehicles, which will work as catalyst to jumpstart the EV. It has also defined the role of federal, provincial ministries and government agencies. The target of penetrating EV in total share is set as a) 30% of car sales by 2030 and 90% by 2040 b) 50% of two- and three-wheeler sales by 2030 and 90% by 2040 c) 50% of bus sales by 2030 and 90% by 2040 (Pakistan 2019). Inducing EV is a major strategy for reducing GHG emissions, but the strategy will be ineffective if the government is facing a shortage of electricity (Nadeem Ul Haque Muhammad Rizwan 2020).

Urban Transport Interventions

Keeping in view the scope of research, the following urban transport interventions made to mitigate the climate impact for achieving resilience in the context of Lahore have been discussed as follows.

Bus Rapid Transit
According to the 2018 Global Bus Rapid Transit data, BRT has been operational in more than 160 cities due to its affordability and potential for stimulating urban growth and catering to the need of the general public for transportation. BRT is also one of the ways to reduce carbon emissions causing climate change due to the excessive use of private automobiles.
The first BRT in Pakistan was introduced in Lahore as Metro Bus Service (MBS). It's a partnership with the Government of Turkey, and the Government of Punjab, on a Build-Operate-Transfer (BOT). The total cost for the 27-kilometer MBS in Lahore cost of approximately PKR 30 billion (US $ 0.28 billion). The Punjab Mass Transit Authority (PMA) operates the MBS with 64 articulated buses at 27 stations from Gajumata to Shahdara and runs seven days a week from 06:15 to 22:00. 64 bi-articulated air-conditioned buses have a capacity of 160 seats. The fare irrespective of destination was initially 20 PKR and has been increased to 30 PKR. An automated fare collection system with off-board ticketing both in cash and metro card is available. The daily ridership of the Metrobus exceeds 180,000 with the peak hourly ridership being 10,000 passengers per hour per direction (p/h/d). The highest ridership recorded was 179,104 persons (Government of Punjab 2022; Imran, Mehmood, and Cheema 2018; Javid et al. 2018; Malik et al. 2021; Punjab 2022; Zolnik, Malik, and Irvin-Erickson 2018).
The MBS gained popularity in a few months against the other public transport available, the upsurge in passengers is proof of this statement. It has played a major role in reducing air pollution in its corridor, by decreasing the number of trips along this corridor and resulting in less consumption of fuel by other modes and an ultimate modal shift. The upshot of all, MBS has proved to be socially and economically beneficial, and

environmentally sustainable. Besides all these, it has also improved the regional linkage. Along these, it is a way forward for achieving SDG 11.2 (Hameed 2014; Majid, Malik, and Vyborny 2018).

Mass Rapid Transit

The successful implementation of the BRT project encouraged the government to initiate Pakistan's first metro train, the Orange Line project, in Lahore. Orange Line Metro Train (OLMT) is the first automated (driverless) rapid transit in Lahore, Pakistan. The line spans 27.1 km with 25.4 km elevated and 1.72 km underground. The line is served by 26 stations and is expected to handle 250,000 passengers daily. The project was initiated in collaboration with the Government of China in May 2014. The construction was started in October 2015 and completed in two-phased. The trial operation of the metro train was carried out in May 2018. However, the operation of the metro train was formally started on 25 October 2020. The metro train line has a total of 26 stations, 2 stations are undergrounded while the remaining 24 are elevated. Each train comprises five wagons automated and driverless. A trainset consisting of 5 cars with 4 doors each used. Each one has a nominal capacity of 200 seated and standing passengers at an average density of 5 persons per square meter with 20% of passengers seated and 80% standing. A total of 27 trains with 135 cars have been ordered for the system. A total of 54 trains are expected to be in service by 2025 It is operated by the Punjab Mass Transit Authority and forms part of the Lahore Metro system. It is a part of the wider CPEC China-Pakistan Economic Corridor, the Orange Line is being financed by both the Government of Pakistan, and the Government of China (Authority 2022; Wikipedia 2021b).

CONCLUSION

Based on policies and projects completed in Lahore, Punjab, and Pakistan; and reviews on Vision 2025, climate change policies, NTP-2018, and NEVP, the findings suggest that policies will work well when implemented properly. Implementation barriers are the main challenges in the context of Pakistan. A comprehensive institutional framework is required to implement all these policies. It has also been observed that the only upgradation in the objectives of climate change policy (2012-2021) in the context of transport was the inclusion of NEVP 2020. NTP-2018 was not fully implemented due to institutional disconnection and political barriers. All referred policies are suggested to promote the non-motorized mode of transport but lack the implementation strategy. One of the ways to improve walking and cycling is by improving access to facilities, and public connectivity, and by educating people. One of the objectives of the research is to find out the impact of urban transport interventions on achieving transport resiliency, the major projects are the metro bus service, and the Orange Line Metro train. These two projects are seen as an opportunity and the first step toward breaking typical public transport services. These are the long terms projects to mitigate the carbon emissions generated by the transport industry. Since the BRT has a limited capacity and consequently cannot be the ultimate solution to provide adequate transit facilities for the majority of the population in cities like Karachi and Lahore. Indeed, BRT is successful in very few cities with populations greater than 10 million. The same has been witnessed by the highest number of passengers in peak hours. Two major recommendations can be proposed to improve resiliency in the transport sector based on the finding of this research; First and foremost is to create public awareness of the impact of climatic change. This will help them make better decisions making their trips. Thus, stabilization in emissions from the transport sector can also be achieved through, travel behavioral change that need to be brought into the policy. Secondly, the finding shows that there is a lack of eco-friendly transport infrastructure

and insufficient information on appropriate adaptation measures. Therefore, additional guidelines and strategies related to urban transport resilience need to be proposed for every objective of the policy.

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SPATIAL FORM COGNITION OF HISTORICAL STREETS IN HONGCUN VILLAGE THROUGH A SPACE SYNTAX APPROACH

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ABSTRACT

This study explores the relationship between spatial form and inner vitality, and discusses the impact of three morphological variables on spatial vitality and spatial cognition of residents and tourists. The purpose of this study is to investigate the internal relationship between spatial morphological characteristics, spatial vitality, and people's spatial cognition. In China, the over-commercialization of tourism has led to changes in the historical spaces of many traditional villages, and the problems of homogenization and commercialization have become increasingly obvious. To address this, this study will use a combination of space syntax and cognitive imagery to understand the historical street space. Space syntax theory quantifies the division of spatial scales and studies the relationship between spatial form and human behavior. The concept of cognitive imagery reproduces the user's spatial cognition through imagery, and explores the relationship between spatial elements and cognition. Combining these two theories can better understand the laws of spatial form and behavioral cognition. This study investigates the historical streets in Hongcun village, a World Cultural Heritage Site located in China. The research sample consists 51 tourists who are traveled to Hongcun, and 49 villagers who reside in the study area.

The results show that there is a positive correlation between the degree of integration, intelligibility, and optionality of traditional street space, the vitality of the space, and people's cognition. However, residents and tourists have different perceptions of the same traditional street space due to their different identities and awareness. When formulating protection and utilization plans, the needs of residents and tourists should be considered comprehensively to achieve a reasonable allocation of village spaces. Spatial analysis was performed using DepthmapX software. The results of this study provide a reference for policy makers to better understand the relationship between the spatial form and inner vitality of traditional villages.

Keywords: Traditional village, World Cultural Heritage, Space syntax, cognitive imagery, Historical Streets

INTRODUCTION

Spatial form cognition of historical streets refers to the cognitive processes involved in perceiving, understanding, and interacting with the physical layout and design of historical streets. It involves how individuals mentally represent and navigate through these streets, how they interpret the spatial relationships between various elements, and how they experience and respond to the unique characteristics of the built environment. This study will take Hongcun Village, a world cultural heritage in China as an example. The author will conduct research on the relationship among traditional street space, spatial vitality, and spatial cognition in Hongcun Village.

1.1. Research Aim

In Southern Anhui, China, there are two ancient village that have been inscribed on the UNESCO World Cultural Heritage List namely Xidi and Hongcun Villages
from the year 2000. Both villages are renowned for their well-preserved traditional architecture, urban layout, and cultural heritage. The buildings in these villages exhibit exquisite craftsmanship, with intricate carvings and decorative elements that showcase the rich cultural history of the region.

As an important representative of ancient villages in southern Anhui, and the most complete and culturally authentic representative of ancient villages in Ming and Qing Dynasties in China, Hongcun's street plan, architecture, comprehensive water systems, traditional culture and folk customs are unique surviving examples (Song et al., 2004). In this context, as World Heritage Sites, Hongcun attracts numerous visitors each year, both domestic and international, who come to experience the unique charm, architectural beauty, and cultural heritage of these ancient villages. However, with the acceleration of urbanization and the development of tourism, Hongchun Villages is facing new challenges.

As a response to the diverse needs of tourists and the aspirations of the local community to improve their quality of life, many traditional spaces in Hongcun Village have the rebuilding or construction of tourist service facilities. These facilities are intended to cater to the needs and expectations of visitors, providing amenities, accommodations, dining options, and other services.

However, this process of integrating tourist service facilities within traditional spaces can create dual pressures of disintegration and reconstruction for the traditional spatial form of the village. On one hand, the influx of tourists and the development of these facilities may lead to changes in the physical layout and arrangement of the village. The construction of new buildings or alterations to existing structures to accommodate tourist facilities may disrupt the traditional spatial layout of the village. This can result in a loss of the historical fabric and the harmonious arrangement of buildings and spaces.

In order to explore the relationship between traditional village spatial form, spatial vitality and spatial intention from the perspective of integrity and subjective cognition, this research adopts space syntax-based analysis method to analyze typical street spaces. The aim of the research is to help governments, developers, planners, and managers better understand the relationship between spatial form, spatial vitality, and behavioral cognition. Then provides a decision-making basis for optimizing the spatial form of traditional villages and building a sustainable development model.

1.2. Research Background and Context

Langston et al. pointed out that tourism helps to publicize the cultural value of heritage (Langston, Wong, Hui, & Shen, 2008). Xiaohua, Xinqiu et al. also pointed out that the moderate development of tourism can help revitalize the space of traditional villages, and it is one of the common ways to protect and revitalize traditional villages(Xiao-hua & Xiang-yu,

2018; Xin-qiu & Si-ming, 2015). Precisely because the traditional villages themselves have extremely high historical and cultural value and tourism development value, and the development of tourism has many benefits in promoting economic development and protecting and revitalizing material and intangible heritage. Many traditional villages in China use their own advantages to develop tourism. However, Andereck et al. found that the tourism industry contributes to garbage pollution problems (Andereck, Valentine, Knopf, & Vogt, 2005). Song et al. pointed out that due to the uneven distribution of tourism resources and weak path connections in traditional villages, it is easy to lead to unbalanced village development, which is not conducive to the cognitive experience of tourists and residents (Song et al., 2005). Ruyi et al. pointed out that the "functional expansion" produced by tourism will have an impact on residents' life, culture and ecological environment (Ru-yi, Liu-ke, De-ming, Hong-bing, & Sheng-dong, 2013). COVID-19, which began in 2020, has had a significant impact on traditional villages that heavily rely on tourism as their primary economic source. The pandemic has exposed the economic vulnerability resulting from an overreliance on tourism.

As one of the earliest traditional villages in China to develop the tourism industry, Hongcun has been seriously affected. Since 1986, Hongcun village has embarked on formal tourism development. As a complex World Cultural Heritage site since 2000, Hongcun's tourism and cultural status has risen to a higher level. After more than 30 years of development, the main community who use the space have changed from residents to tourists. Despite undergoing several rounds of protection and renewal, Hongcun village still faces challenges that need to be addressed. Some of these issues include the over-commercialization of tourism, uneven development within the village, commercial reconstruction altering the original functions of buildings, and the presence of non-traditional general layouts and landscape designs.

Traditional research methods are difficult to accurately describe complex spaces such as traditional villages and the impact of tourism on the original space, but space syntax can accurately describe the characteristics of space and the relationship between space and human behavior. Space syntax is a systematic theory about architectural and urban space analysis. It studies the relationship between spatial form and human behaviors, and then it will systematically explain complex and diverse social phenomena (B. Hillier, 2015).

Cognitive intentions are mainly analyzed through mental maps. The mental map is a cognitive sketch based on the intentional feelings from memory, based on the layman's experience of the environment, and has "primitive" and "intuitive". Spatial features and connections that are important and obvious to the experiencer can be identified. The mental map is mainly obtained in two ways: (1) After investigating residents or tourists' spatial psychological feelings and impressions of a certain area, the researchers analyze the obtained information and translate it into a map. (2) Directly draw a spatial perception sketch of a certain area by residents or tourists themselves (J. Wang, 1999).

Although both space syntax and cognitive intention have been widely used in urban planning and other fields, there are still some limitations and controversies when used alone. The combination of the two methods can play a complementary effect. For example, Xiao Feng et al. used the cognitive map method and space syntax to study some areas of the historical urban area of Hengyang City, and found a feasible point where the two theories complement each other (Feng & Shi-si, 2012). Chen Chi et al. used space syntax and cognitive image theory to interpret the relationship between spatial morphological characteristics and spatial cognition in Qinchuan Village (Chi, Bohua, Jiali, & Wen, 2018).

Therefore, this article attempts to take Hongcun Village, a World Cultural Heritage Site, as the research object. It combines space syntax and cognitive intention, explores the relationship between spatial form and cognition, and provides a basis for optimizing the spatial layout of traditional villages and building a sustainable development model.

2. Literature Review
2.1. Spatial Morphology Cognition
Theories of spatial morphology cognition explore how individuals perceive, understand, and interact with spatial environments. Relevant theories mainly include Gestalt Theory, Environmental Cognition, Mental Maps, Spatial Syntax, etc. These theories aim to uncover the cognitive processes and mechanisms underlying spatial perception and cognition.

2.1.1. Gestalt Theory
Kevin Lynch used Gestalt theory to study human perception and understanding of the historical environment, proposed the concept of "image", and discussed the readability and image of the urban environment (Lynch, 1964). Birer, Schroeder et al. used Gestalt theory to discuss people's perception of public space in different regions, and proposed related design principles and methods (Adenaike, Opoko, & Fadamiro, 2022). Gestalt theory proposes that humans perceive and interpret visual information as organized wholes rather than individual parts. It emphasizes the importance of holistic perception and how elements in a spatial environment are perceived as meaningful patterns.

2.1.2. Environmental Cognition
William H. et al. conducted research on environmental cognition from the aspects of spatial perception and the influence of physical environment on human behavior (Ittelson, 1974). Kaplan S. discussed how individuals' cognitive evaluation and emotional responses to the environment affect their preferences and behaviors (Kaplan, 1987). Based on environmental cognition, Eben Saleh et al. evaluated the aesthetic quality and value of Al-Alkhalaf rural landscape in Asir, and pointed out that when looking for a new way of relationship between man and nature, we should start from three aspects: aesthetic value, aesthetic quality and visual quality (Eben Saleh, 2001). This theory explores how individuals mentally construct internal representations (cognitive maps) of the physical world around them.

2.1.3. Mental Maps
Peter Gould et al. gave a comprehensive overview of Mental maps research, and discussed the cognitive processes involved in the creation of Mental maps, influencing factors, and the relationship between Mental maps and behavior (Gould & White, 2012). However, there are also shortcomings in Mental Maps. Paül et al. compared the results obtained by cognitive maps with those obtained by measuring heart rate variation (HRV), and found that there was a large difference between the results obtained by the two methods (Paül i Agustí, Rutllant, & Lasala Fortea, 2019). These maps help individuals navigate through their environment, make wayfinding decisions, and understand spatial relationships between different places.

2.1.4. Spatial Syntax
In order to supplement the lack of subjective cognition, Hillier used space syntax to explore the artificial nature of spatial forms in architecture, as well as the contingency and inevitability thereof, providing a valuable reference for understanding the generation of spatial forms in architecture (Bill Hillier, 1985). However, space syntax also has certain limitations. Yamu et al. pointed out that as an auxiliary decision-making and technical analysis method, space syntax has certain limitations in the study of the relationship between space and people. If it is difficult to discover complex spatial characteristics and details such as architectural style and cultural characteristics, and lack of consideration of context and emotion, it should be used in combination with other methods to obtain a more accurate and comprehensive understanding (Yamu,

van Nes, & Garau, 2021). These studies provide important perspectives for our in-depth understanding of the cognition and application of spatial form. On the basis of these researchs, this study will combine spatial cognitive intention and space syntax to comprehensively analyze the historical streets of Hongcun Village. It quantifies spatial properties like integration, connectivity, and visibility to understand the relationships between spaces and their impact on human movement and cognition.

2.2. Space Syntax

Space Syntax was formulated by Bill Hillier and Julienne Hanson with their colleagues. It is a theoretical and analytical framework used to study the relationship between spatial configuration and human behavior in the context of architecture, urban planning and design. It provides a systematic approach to understanding how the arrangement and connectivity of spaces influence movement patterns, social interactions, and spatial experiences. Space syntax analyzes the spatial layout and connectivity of streets, buildings, and open spaces within a given environment. The analysis involves the use of graph theory and mathematical models to quantify and represent the spatial relationships between different elements in a network. The findings from space syntax analysis can inform design and planning decisions, guiding the layout of spaces, the positioning of landmarks, and the connectivity of networks (Bill Hillier, 1997, 2009; Bill Hillier, Penn, Hanson, Grajewski, & Xu, 1993).

After the 1980s, space syntax has been rapidly used and developed in both theory and practice. Relevant research in the field of urban and rural planning mainly focuses on three aspects: spatial form research, public space analysis, and historical space protection.

2.2.1. Spatial Form Research

Fu Lieshan et al. used space syntax to analyze the urban spatial structure of the sixth edition of the master plan of Zhuzhou City, and analyzed the causes and internal mechanisms of the morphological changes from the basic and social levels (Lieshan, Jian, & Junlin, 2010). Zhan Q et al. analyzed the spatial pattern of large stores based on space syntax theory, and explored the correlation between changes in syntactic accessibility and the spatial pattern of large stores (Zhan, Zhou, & Sliuzas, 2009). Giannopoulou et al. verified and explained the functional structure of the city by using space syntax to identify the core form of the city, the main and most congested road axes, and the allocation of central land use (Giannopoulou, Roukounis, & Stefanis, 2012). Spatial form research plays a crucial role in enhancing our understanding of how spatial layouts impact human experiences and interactions with the built environment.

2.2.2. Common Space Analysis

Monokrousou et al. used space syntax, GIS database, etc. to explain and predict pedestrian movement in public space, and proposed a method framework to overcome these limitations (Monokrousou & Giannopoulou, 2016). Ingy et al. analyzed the outdoor spaces and routes of a university campus in the Delta region (Egypt) and students' perception of outdoor spaces based on space syntax. The importance of providing appropriate places, paths, and routes for social interaction on campus that meet the needs of students is noted. And based on the space syntax theory, an optimization strategy is proposed (El-Darwish, 2022). Wiem et al. used space syntax to analyze the city of Kuikul, an Algerian Roman city located in Sétif, and discussed the spatial structure of the city and how public space is used for movement, activities and interactions between people (Zerouati, 2022). It is a quantitative approach that analyzes the patterns of connectivity and integration within a space to uncover the relationships between different elements and how they influence human movement and behavior

2.2.3. Historical Space Protection

Wang Chengfang et al. based on the theory of space syntax and cognitive

imagery, explained the internal relationship between the spatial morphological characteristics of Qinchuan Village and spatial cognition, and proposed specific optimization strategies (Chengfanga & Yimina, 2012). Taking Xiaozhou Village in Guangzhou as an example, Tao Wei et al. discussed how the spatial form of the village affects users' spatial cognition, and pointed out that some landmark elements played a more significant role in spatial cognition (Wei, Hongye, & Jieyong, 2013).

2.3. The Spatial Cognition of Historic Streets

Historical streets usually refer to those streets with a long history and rich cultural heritage. They have important cultural, scientific, educational and aesthetic values, and are also one of the most attractive spaces in the city. Research on the spatial cognition of historic streets aims to understand how individuals perceive, navigate, and interact with the physical environment of historical street settings and sustainable development of historical streets, and then play a guiding role in the space optimization. Relevant research mainly focuses on perception and sensory experience, spatial orientation and wayfinding, social interaction and behavior, cultural and historical context, etc. Spatial cognition research often employs techniques such as cognitive mapping, eye-tracking studies, and behavioral observations to gain insights into how people perceive and interact with historic streets.

2.3.1. Perception and Sensory Experience

Scheer et al. pointed out that historical streets help to enhance the city's sense of place and identity, and the street and plot patterns should be protected (Scheer, 2020). Zhu et al. studied the relationship between tourists' landscape evaluation and place attachment in historical districts, and pointed out that tourists' visual preference, authenticity evaluation and destination image have a significant positive impact on place attachment (Zhu & Chiou, 2022). Overall, perception and sensory experience significantly shape how individuals interact with the world, enriching their understanding of their surroundings and contributing to their overall sensory well-being.

2.3.2. Spatial Orientation and Wayfinding

Srinurak et al. took the exit point and accessibility of the urban network as the research object, combined space syntax with GIS, analyzed the urban form and street accessibility of historical areas in Chiang Mai, and provided route planning suggestions for safe evacuation in historical areas (Srinurak, Mishima, Fuchikami, & Duangthima, 2016). Wang et al. used multi-source data to analyze the ancient town of Fengjing in Shanghai, and pointed out that clear tourist space boundaries, rich folk activities, and continuous tourist routes can help tourists form a more systematic spatial cognition (L. Wang et al., 2022).

2.3.3. Social Interaction and Behavior

Xu et al. used the micro-scale built environment (MiBE) variable system to capture the characteristics of historical streets, and recorded the walking and stopping behavior of 109 tourists in Wudaoying Hutong, and found the influence of cultural related factors on tourists' walking behavior (G. Xu, Zhong, Wu, Zhang, & Zhang, 2022). Mundher et al. used photo surveys, Likert scales, and heat map analysis techniques to assess the visual quality of historical streetscapes and identify elements that might affect them. Finally, they pointed out that modern building facades can have a negative impact. However, unique cultural and religious buildings, green plants can have a positive impact (Mundher, Al-Sharaa, Al-Helli, Gao, & Shamsul Abu, 2022).

2.3.4. Cultural and Historical Context

Ja'afar et al. focused on the vegetation, street furniture, water features and paving materials in three traditional streets in Malacca, emphasizing the important role of these landscape features in enhancing the aesthetics, culture and function of traditional streets in Malaysia (Ja'afar, Sulaiman, & Shamsuddin, 2012). Zhang et al. used Internet data such as Tencent

location big data to study some historical and cultural blocks in China, and established an index system for the protection and development of historical and cultural blocks. They pointed out that historic blocks have profound historical and cultural heritage and life form characteristics, and they should be accurately positioned to achieve healthy and sustainable development of protection and utilization of the area (J. Zhang, Huo, Zheng, Zheng, & Zhang, 2017).

Existing studies have analyzed the spatial cognition of historical streets from different angles, but none of them can fully reflect the relationship between the three aspects of spatial structure, spatial social nature, and spatial image cognition. Based on these, this research combines space syntax and cognitive intention to explore the cognitive rules and mechanisms of tourists and residents in the historical streets of Hongcun Village, and reveal how people perceive and participate in these unique street environments. And provide a basis for optimizing the spatial layout of traditional villages and building a sustainable development model.

3. Methodology
This research was conducted in two phases. The first stage is qualitative research, the purpose is to describe and analyze the unique street environment and people's behavior perception in Hongcun Village. The author and the team conducted three preliminary investigations in Hongcun Village on April 15, May 20, and June 17, 2023. The main purpose is to:
(1) Understand the distribution and characteristics of streets and alleys in Hongcun, and establish a basic understanding of the area.
(2) Obtain a heat map through Baidu Maps to understand the approximate distribution of the crowd.
(3) Observe the behavior trajectory of residents and tourists, and understand the characteristics of most people staying in the photo space in the streets and alleys.
(4) In the form of questionnaires and interviews, cognitive surveys were conducted among local residents and tourists to obtain samples of mental maps. A total of 100 valid samples were collected, including 51 tourists and 49 local residents. Incorporate the data of spatial cognition elements of different groups into the statistical analysis of space syntax, and compare and explore the internal relationship among group identity, spatial form, spatial cognition, and environmental behavior.

The second stage is quantitative research. This paper mainly uses the axis method in space syntax and Depthmap software to analyze the spatial form cognition of Hongcun Village. The following three morphological variables are mainly used:
(1) Integration value. Designed to analyze the degree of agglomeration or dispersion of a space relative to other spaces in the system.
(2) Optionality. It aims to investigate the number of times a space appears on the shortest topological path, indicating the potential of a space to attract crossing traffic.
(3) Intelligibility. It aims to analyze the ability- to perceive the overall space from the connectivity of the local space.

MAIN RESULTS

4. Case Study
4.1. Overview of Historical Streets in Hongcun Village
Hongcun Village is located in the northeast of Yi County, Huangshan City, Anhui Province, China. It was built in the first year of Shaoxing in the Southern Song Dynasty (AD 1131), and has a history of 892 years. As a world cultural heritage site, Hongcun Village is an important representative of traditional villages in Huizhou, and it is also a clan-style settlement where people live together. The construction of the village is influenced by traditional Chinese Fengshui theory and Cheng-Zhu Neo-Confucianism, forming a unique cow-shaped village (H. Xu, Wan, & Fan, 2014). It takes the mountain as the head, the tree as the corner, the building complex as the body, the bridge as the corner, the moon marsh as the stomach,

and the artificial water well as the cow's intestines (Figure 1). Until now, Hongcun Village still preserved the overall pattern of the village, the traditional street structure and more than 130 traditional residential buildings left over from the Ming and Qing Dynasties.
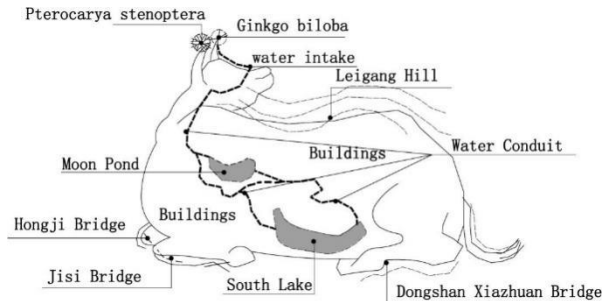
Figure 1 Intention Analysis Diagram of Hongcun Village Bull Shape

The development of material space in Hongcun Village roughly went through five stages: the settlement stage (AD 1131-1276), the development stage (AD 1276-1607), the peak stage (AD 1607-1855), the decline stage (AD 1855-1976), and the re-development stage (AD 1976-present) (Minghao, 2006). From the initial four residences on Leigang Hill, Hongcun Village gradually developed to a village centered on Moon Pond and Ancestral Hall of Wang Family, and then to the construction of South Lake and South Lake Academy in its heyday, Hongcun gradually formed a three-level street system. The first-level streets, such as Hongcun Street, Back Street, Hubin North Road, etc., are mainly 2.3m~3.5m wide, and the space is relatively open. The second-level streets, such as Chahang alley and Shangshuizhen alley, are mainly in the width of 1.4m~2.2m. They are the streets with the most abundant spatial changes and the most distinctive features in the village. Most of the third-level streets have no names, and the width of the streets is mainly 0.5m~0.9m, which is very narrow and can only meet the traffic demand. In terms of street form, the roads in the entire village form a ring-like centripetal structure with the main temple and the Moon Pond as the center. The streets near the ancestral hall buildings and the Moon Pond on the outer ring road are relatively regular in shape. The vertical

and horizontal streets and alleys are perpendicular to each other. The streets and alleys in other areas are relatively free. According to the spatial structure of Hongcun Village and the results of field research, the author uses the axis to represent the skeleton of the streets and alleys of Hongcun Village, forming a spatial texture map of the main streets and alleys of Hongcun Village (Figure 2).

Figure 2 Spatial Texture Map of Historical l Streets in Hongcun Village

4.2. Data Acquisition: The Spatial Syntax Analysis of Historical Streets in Hongcun Village

Based on the spatial texture map of the main streets and alleys of Hongcun and the results of field surveys, the author draws the traditional streets of Hongcun into a spatial axis diagram. Then save the axis diagram as a *.dxf file and import it into the space syntax analysis software DepthmapX to generate a diagram of syntax variables and analyze the degree of spatial integration, intelligibility and selectability.

degree is relatively higher, and the overall accessibility is better. In the local integration map, it can be found that the streets in the middle and south of the village are highly integrated. On the one hand, it is because the ancestral hall and the residence of the big family surnamed Wang occupy the best location in the center of the village. On the other hand, it is because this part of the space has been developed in the process of tourism
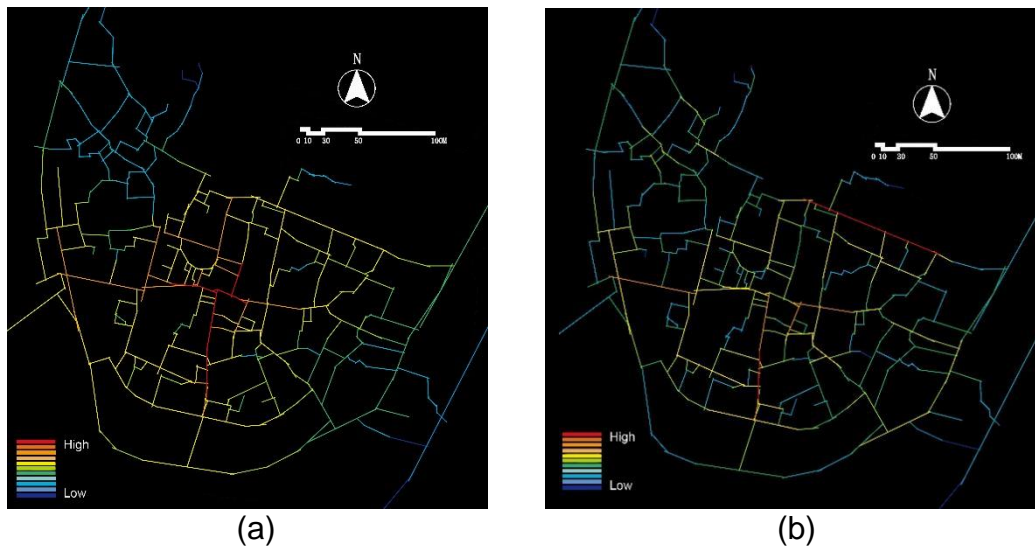
Figure 3 Analysis on spatial integration degree of streets in Hongcun Village:(a) Global Integration, (b) Local Integration

4.2.1. Spatial Integration Analysis

The degree of integration indicates the relative accessibility of spatial nodes. The higher the degree of integration, the stronger the accessibility of the space in the region. Red is the maximum value and blue is the minimum value (Bill Hillier, 1996). From the axis diagram of Hongcun's overall integration degree generated by DepthmapX software (Figure 3), it can be found that the core areas with a high degree of integration are mainly distributed around South Lake (Nanhu) and Moon Pond (Yuezhao). Hubin North Sidewalk and Hongcun Street having the highest degree of integration, then followed by Front Street and Back Street. The average global integration degree of Hongcun Village is 0.63, and the axes greater than 0.63 account for 55.2% of the total number of axes. The results show that the streets in Hongcun Village are well connected, the overall integration

development.

The closer to the village edge, the lower the global integration degree. It shows that the connectivity and accessibility of streets and alleys in marginal areas are poor. And this is in line with the typical characteristics of clan-style settlements like Hongcun Village, which attaches great importance to the communication within the clan. There are very few nodes connected to the outside world, reflecting strong defensiveness and repulsion. But in terms of the actual needs of residents, the low degree of integration at the edge of the village is not suitable for people's life today.

4.2.2. Spatial selectivity analysis

The degree of selectivity can reflect the number of times the shortest path between any two spaces in the village is selected. The higher the degree of selectivity, the stronger the attraction of the space node.

The authors used DepthmaX software to generate angular selectivity and topological selectivity axis plots (Fig. 4). It was found that the three streets with a high degree of selectivity were mainly Hongcun Street, front street, and back street, which highly overlapped with the areas with a high degree of spatial integration. Judging from the actual research, there are a large number of public buildings and space

(a)   (b)
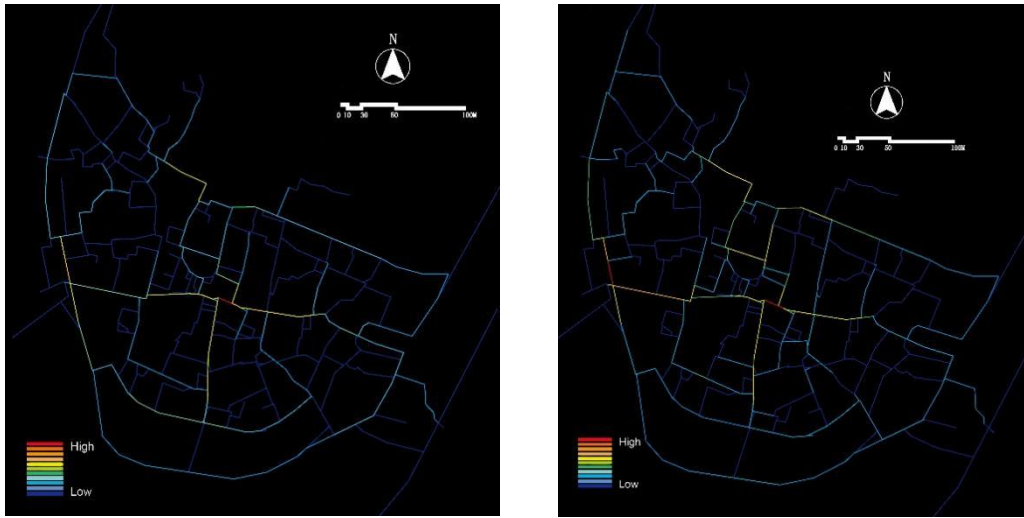
Figure 4 Analysis on spatial integration degree of streets in Hongcun Village:
(a) Angular selectivity, (b) topological selectivity

(a)   (b)

(c)

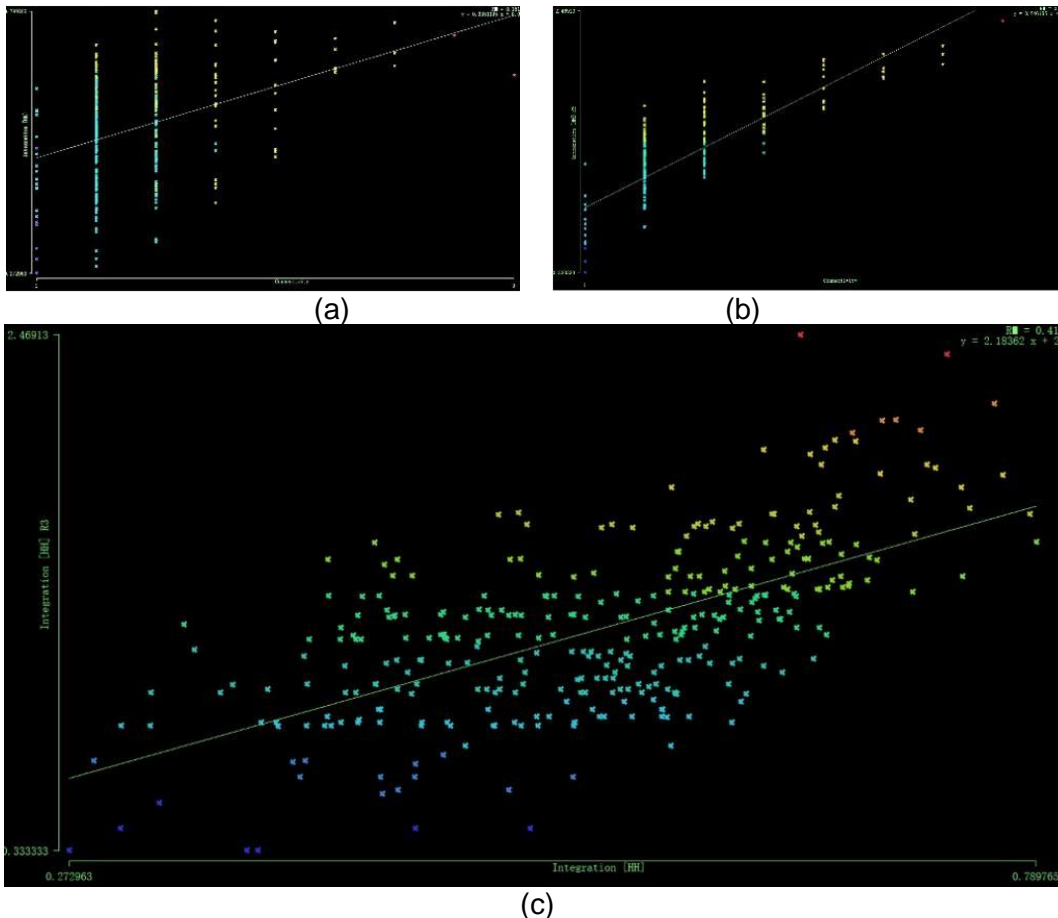**Figure 5** Analysis on spatial integration degree of streets in Hongcun Village: (a) Correlation analysis between connection value and global integration degree, (b) Correlation analysis between connection value and local integration degree，(c) Correlation analysis of global integration degree and local integration degree

nodes on both sides of Hongcun Street, Front Street, and Back Street, which were the core space of production and life in Hongcun Village. It has both the function of passage and the potential of being a destination.

4.2.3. Spatial intelligibility analysis

Intelligibility reflects whether the local spatial structure can help people establish an understanding of the entire spatial system. Both connectivity and integration are high, indicating that this is a well-understood spatial system. Further, a high degree of understanding indicates a strong consistency between the local space and the overall space. In the DepthmapX software, the author first selected two sets of data of spatial connectivity and global integration (Integration (Q. Zhang, Bai, & Zhao)) for linear regression analysis (Figure 5(a)), and R^2 was 0.151. Then select the two sets of data of spatial connectivity and local integration ((Q. Zhang et al.)R3) for regression linear analysis (Figure 5(b)), and R^2 is 0.64. Then, two sets of data of global integration (Integration (Q. Zhang et al.)) and local integration (Integration (Q. Zhang et al.)R3) were selected for linear regression analysisto analyze the

that the spatial connection value of streets and alleys in Hongcun Village is not strongly correlated with the global integration degree, but is strongly correlated with the local integration degree, and the intelligibility of the street and lane system is average. This interesting result shows that Hongcun is a large space with poor intelligibility composed of several small spaces with good intelligibility. The primary reason for this result is that the formation of Hongcun Village is mainly based on bottom-up construction by villagers, so several small spaces with better intelligibility have been formed. Secondly, tourism intervention in the later period further sorted out the road network structure in the central area on the basis of the original spatial texture, and strengthened the intelligibility of the space (Jinlong, Lei, & Xiaohua, 2017).

4.3. Data Acquisition: Spatial Vitality Analysis of the Historical Streets of Hongcun Village

Judging from the distribution of the flow of people shown in the heat map of Baidu Maps, the crowds are mainly concentrated on Hongcun Road and the west side of Moon Pond on weekends and holidays (Figure 6). Take May 20, 2023 as an
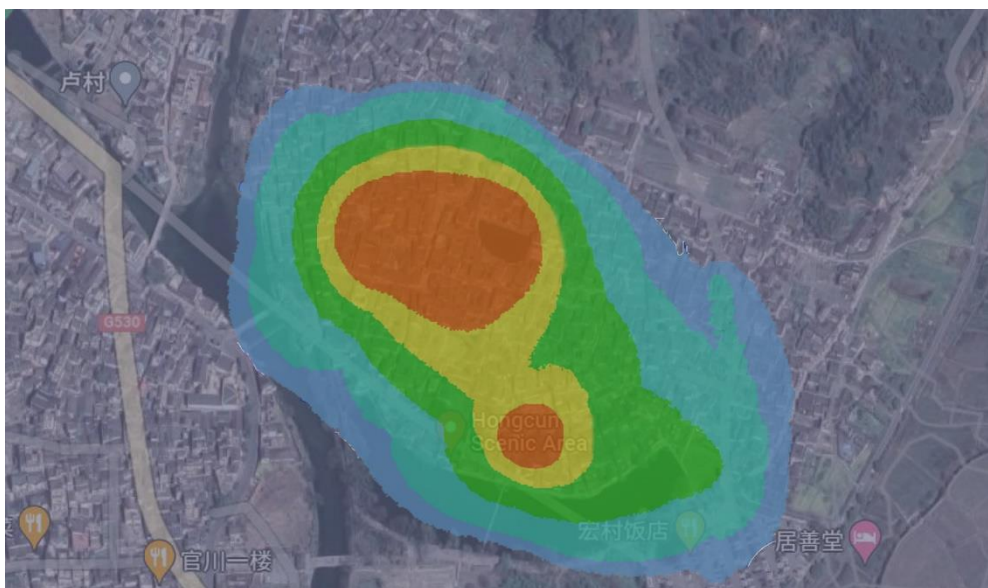

Figure 6 The main distribution of the flow of people in Hongcun Village
(at 10 am on May 20, 2023)

relationship between the local space and the overall space of Hongcun Village (Figure 5(c)), R^2 is 0.413. The results show

example. Around 8:00 in the morning, the number of tourists gradually increased, and the crowds were mainly concentrated

near Hubin North Road. Around 10:00, the crowd began to concentrate on Hongcun Street and the west side of Moon Pond, and the situation basically lasted until around 6:00. Afterwards, the crowd began to move towards the exit on the west side of the Moon Pond. Some people staying in this village are scattered on the west side of Moon Pond and the east side of Hubin North Road.

On non-holidays, when tourists are less, the back streets, Shangshuizhen, Chahang street become more vibrant areas in the village. Villagers gather here to chat, wash clothes, and bask in the sun.

4.4. Data Acquisition: Spatial Cognitive Analysis of Historical Streets in Hongcun Village
4.4.1. Spatial cognition analysis of residents and tourists
The space syntax theory believes that areas with a higher degree of integration

cognition results of residents and tourists. Based on the mental map, the author found that the three most impressive historical streets for tourists are Hongcun Street, Hubin North Road, and Front Street. The three most impressive scenic spots are South Lake, Moon Pond, and South Lake Academy. The three historical streets that residents are most impressed with are Hubin North Road, Hongcun Street and Back Street. The three most impressive scenic spots are South Lake, Moon pond, and Shuizhen street (Table 1).

According to the results of the on-site follow-up investigation, there are two main routes for the flow of people, both of which pass through Hubin North Sidewalk, Hongcun Street and Front Street.
(1) South Lake→South Lake Academy→ Jingde Hall→Wang Daxie's Former Residence (Zhenqi Hall) →Moon Pond→

Table 1 Hongcun Spatial Cognitive Elements Occurrence Frequency Statistical Table

Identity	Street Name (Frequency)	Attractions (frequency)
Tourists	Hongcun Street (42) Hubin North Sidewalk (21) Front Street (15) Shangshuizhen Street (10) ongtangli Alley (10) TingqianLu Street (9) Linhu Street (7) Chahang Alley (6) Huanbi Alley (4) Middle Street (4) Others (4) Back Street (1)	South Lake (37) South Lake Academy (31) Moon Pond (29) Ancient Trees at the Entrance of the Village (14) Jingde Hall (10) Chengzhi Hall (9) Taoyuan Residence (7) Wang's Ancestral Hall (7) Shuren Hall (6) Water Town (5) Jingxiu Hall (4) Deyi Hall (4) Biyuan (4) Wang Daxie's Former Residence (3) Ancient Theater (3) Leigang Hill (0) Others (0)
Residents	Hubin North Sidewalk (38) Hongcun Street (22) Back Street (21) Shangshuizhen Street (15) Linhu Street (13) Chahang Alley (11) Middle Street (7) TingqianLu Street (8) Front Street (6) Others (4) Huanbi Alley (1) Nongtangli Alley (1)	South Lake (41) Moon Pond (32) Water Town (29) South Lake Academy (28) Ancient Trees at the Entrance of the Village (18) Wang's Ancestral Hall (13) Chengzhi Hall (12) Jingde Hall (9) Ancient Theater (5) Taoyuan Residence (5) Others (5) Biyuan (3) Shuren Hall (3) Jingxiu Hall (3) Deyi Hall (2) Leigang Hill (2) Wang Daxie's Former Residence (1)

have more frequency of use and flow of people, and are easier to be remembered by people (Wei et al., 2013). In order to compare with the analysis results of space syntax, the authors analyze the spatial

Lexu Hall→Jingxiu Hall→Chengzhi Hall→ Deyi Hall→Shuren Hall→Taoyuan Residence

(2) South Lake→South Lake Academy→ Water Town→Jingde Hall→Moon Pond→ Wang's Ancestral Hall→Jingxiu Hall→ Chengzhi Hall→Shuren Hall→Taoyuan Residence→Ancient Trees at the Entrance of the Village

4.5. Data Inference: The relationship between spatial cognitive imagery and global integration

Cognitive survey results show that the respondents have a high degree of awareness of local space. In the local space, residents and tourists have the highest awareness of scenic spots, followed by streets. 54% of the aborigines can fully describe the overall spatial structure of the village, 36% of the new residents can also fully perceive the overall space of the village, while only 18% of tourists can fully perceive the overall space of the village. The specific reason is that the aborigines have lived in Hongcun Village for a long time, so they have a high awareness of the spatial structure of the village. The new residents don't stay for a long time, and most of them only know the areas where they often move. For tourists, the spatial structure of Hongcun Village is complex, and the global intelligibility of the space is relatively low, so it is difficult to understand the overall spatial layout of Hongcun Village through partial space. In addition, the commercial atmosphere of the local space is too strong, the lack of participatory folk activities to connect the whole space, and the short stay time are also one of the reasons for the low understanding of the space for tourists.

The results of the cognition survey also show that the historical streets with high awareness among villagers and tourists are Hongcun Street, Hubin North Sidewalk, Front Street and Back Street. It is basically consistent with the streets which have high degree of integration, selectivity and intelligibility determined by the quantitative analysis of space syntax. This conclusion also verifies the viewpoint of space syntax theory. From the perspective of space, the scale of these historical streets is relatively appropriate. The width of the road and the height ratio

(D/H) of the enclosed buildings on both sides (or one side) are both between 1/2~1/3, which can make people feel friendly. The direction of the street is strong, but the angle changes, so that people can't see the end at a glance, which can generate better attraction. In addition, the architectural style with regional characteristics and the unique performance of the landscape in the space strengthen people's recognition.

Among the four historic streets, Hongcun Street, Front Street, and Back Street are surrounded by traditional Huizhou buildings with regional characteristics. However, the facades of the buildings in the back street are not uniform enough, the commercial atmosphere is weak, the flow of people is small, and there are no unique attractions, so most tourists do not enter. The north side of Hubin North Road is Huizhou-style buildings, and the south side of the South Lake is relatively empty, so you can better appreciate the natural scenery of the South Lake and its surroundings. Regrettably, although there are many tourists, most of them don't stay in these streets for a long time. They basically just take a photo and then leave.

In terms of cognition of the street space, due to different identities, different stay time and familiarity, there are certain differences in the cognition of the space between tourists and residents.

Traditional streets with high tourist awareness are greatly affected by traffic, scenic spots and commercial atmosphere. Among them, Hongcun Street and Front Street are the busiest streets in Hongcun Village. The traditional Huizhou buildings on both sides are filled with various snacks and small commodities, including Chinese clothing such as Han-style clothing and cheongsam, four treasures of study such as brushes and inkstones. Although the tourist awareness is high, many tourists complain that the commercial atmosphere is too strong, tourism products lack regional characteristics, and are too homogeneous compared with other regions. They suggested developing more

small commodities with Hongcun characteristics, and increasing folk activities that tourists can participate in, so that tourists can truly feel the unique cultural charm of Hongcun Village. Hubin North Sidewalk is the best way to see the South Lake and take pictures in Hongcun, and it is distributed with scenic spots with high tourist awareness such as South Lake Academy and Huxin Building.

The three streets with the highest awareness among villagers are more focused on life. Among them, Hubin North Sidewalk and Hongcun Street overlap with tourists' cognition, while Back Street has obvious difference with tourists' cognition. The reason for residents who have a higher awareness of Hubin North Sidewalk is that it is close to the South Lake, has better natural scenery, and is the only way for some villagers to enter the village. The reasons why residents have a high awareness of Hehongcun Street are: (1) It is also the only way to enter the village, connecting the two core areas of Nanhu and Yuezhao. (2) Some villagers participate in commercial operations on Hongcun Street, or as local tour guides, often take tourists to visit and shop here. However, some villagers also complain that the commercial atmosphere of Hongcun Street is too strong, which weakens the regional characteristics. The traffic flow of people during holidays is too large, which has a great impact on their traffic and normal life. The Back Street located on the north side of the village is a street formed in the early stage of Hongcun's development. With the development of the village to the south, although the status of the back street has gradually weakened, the villagers still have a strong awareness of it. There are two reasons why residents have a high awareness of this historical street: (1) It is less disturbed by tourism, and residents prefer to choose activities in it; (2) Public service facilities such as village committees and elderly activity centers are distributed in the street.

4.6. Suggestions for Historical Streets in Hongcun Village and Future Research

The purpose of studying the historical streets in traditional villages is to better protect and utilize traditional spaces and serve residents and tourists. Based on the space syntax analysis of the historical streets in Hongcun Village and the spatial cognition analysis of the residents and tourists on the historical streets of Hongcun Village, some suggestions for optimizing the space of the historical streets in traditional villages are put forward:

(1) Hongcun Village can moderately improve the connectivity of the roads in the core area, increase the complexity of the space, and set up folk activities that tourists can participate in in multiple open node spaces to extend the time for tourists to visit. This method can not only improve tourists' awareness and understanding of space, but also avoid periodic congestion in a certain space. For fringe areas with low integration and intelligibility, moderately increase the external connection, improve the convenience of residents' life and the overall integration of the village. Repair the incomplete streamlines of streets and alleys, repair the internal road surface, and increase the accessibility and safety of these spaces, and meet the daily needs of residents.

(2) Historical streets are one of the most original characteristic elements in traditional villages, but the development of tourism activities will overlap the living space originally belonging to residents and the tourist space of tourists, and even invade and destroy the original space in the village (Xi & Zhenyu, 2012). Similar problems exist in Hongcun Village at this stage. The daily flow of tourists should be reasonably controlled according to the actual space capacity, so as to avoid the impact of excessive commercialization on the daily life of residents. In addition, the living space of the aborigines should be considered reasonably, the activity of the public space should be maintained, and the disorderly penetration of tourism should be avoided to completely turn traditional villages into scenic spots. The vitality of traditional villages should not only focus on the number of tourists, but

also consider the needs of the aborigines. Only by enhancing the endogenous power of traditional village protection and development can it be conducive to the sustainable development of heritage (Hong-gang, Xiao-juan, & Xiao-jun, 2012).

(3) Historical streets are the sequence and connection of traditional spaces, and historical streets with a high degree of integration and selection are easier to be recognized by people. The development and utilization of traditional villages should focus on protecting the street space in the original settlement, so that the new space and the old space have a similar topological relationship—Topological Isomorphism. In addition, we should focus on the development and utilization of historical streets with a high degree of integration and selection. Tourism activities should be carried out by strengthening the attraction of scenic spots in the streets, the accessibility of the streets, and the uniqueness of landmarks. Hongcun Village makes better use of the original streets as tourist routes and commercial streets in tourism development, which is worth learning for future generations.

CONCLUSION

This paper attempts to use space syntax and spatial cognitive intention to explore the relationship between spatial form and inner vitality. Taking Hongcun Village, a world cultural heritage, as an example, the research is carried out. By analyzing the spatial integration, comprehensibility, and selectability of the historical streets in the village, the spatial vitality of the streets, and the cognition of the street space by residents and tourists, the internal connection between the three is found. From the analysis results, there is a positive correlation between the degree of integration, intelligibility and selectability of space, the vitality of space and the degree of human cognition. However, residents and tourists have different perceptions of the same street space due to their different identities. When formulating protection and utilization plans, the needs of residents and tourists should be considered reasonably to achieve a reasonable allocation of space. Streets in traditional villages have their uniqueness, and their inherent spatial advantages should be fully utilized and strengthened, and insufficient repairs should be made. Finally, the overall intelligibility of the village is improved to meet the needs of modern life.

This study also has some limitations. Since the number of samples of residents and tourists in the actual survey is not large enough, it cannot fully reflect the cognition of residents and tourists to the street space. In order to improve the reliability of the research results, more residents and tourists will be interviewed in future research, detailed viewshed analysis will be added, and more effective methods will be used for analysis.

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YOUTH TRAVELERS DECISION MAKING TO TRAVEL THROUGH SOCIAL MEDIA

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ABSTRACT

Social media sites are used more frequently than the physical participation of individuals in nowadays communication. Individuals, especially youth travellers meet online to share their opinions and information, express views, and regularly updated their status or post blogs, videoblogs and microblogs. The broad development of information and communication technology especially in reviewing the details of the tourism products, destinations and activities, shows that travellers are depending on their reviews for the travel decision-making process, which associated with the emergence of social media especially from the past experience users points of views. Despite the gap of micro studies, the overall picture on how and which factors, influence what phases of the travel and throughout all stages of the decision-making process remain unclear. The aim of this study is to fill the research gap in connecting the youth's travel behaviour and their social networking usage to understand on how much and in which factors social media can influence youth travellers' decision making. The research was based on a sample of 350 Malaysian youth travellers ranging from 18-38 years old in investigating on how the information search through social media influences the behaviour intention to travel, which then quantitatively analysed using Structural Equation Modelling (SEM) and Regression Analysis to answer the research objectives. The main findings of this study indicated that youth travellers value the perceived usefulness of social media for knowledge seeking (push factors), and this leads to their intention to visit a destination. This research makes contributions to the knowledge. The tourist behaviour theory by proposing information exchange as an enlarged tourist behaviour construct especially influence by the type of generations. Next, to relate the social media with the travel decision behaviour by identifying specific medium and what factors that contributes specific decision-making process.

Keywords : Social Media, Youth Travelers, Travel Decision Making

INTRODUCTION

The travel and tourism sector are very important for the economic growth of both developed and developing countries. Nowadays, tourism is mostly connected with the internet where tourists can always search for any information needed on the web and most of the platforms used by the tourist would be social media. Today, the Internet usage has grown by 1,066% from2000 to 2018; while worldwide Internet user number has reached to 4.208 billion (Internet World Stats, 2018). The Internet has changed the lifestyle of consumers dramatically from the way they shop, search, read, communicate, and so on. Social media is commonly known as a platform in a form of electronic communication that enables users to create, share or even exchange information, ideas, experience, images and videos (Ackland & Kyosuke, 2015; Benea, 2014). It is also known as a tool for users to rely on for deciding on anything, make it in the retailing, health, education and even tourism industry. This happens because social media plays a major role in influencing the decision making for the users since a lot of information as well as experiences are shared virtually on the web nowadays (Benea, 2014, Veríssimo & Menezes, 2016).

In the tourism context, social media prepare platforms for tourists to find information and also share their knowledge and experience with other tourists. Reviews that are prepared by the tourists can be used as a tool or mechanism in helping other tourists decide on certain destinations or activities (Dusíková, 2018). Most of the tools of social media that are used by tourists are Facebook, Instagram, Twitter, TripAdvisor, Trivago, Booking.com and a lot more. These tools can influence the tourist decision making on their tourism preference and activities

Therefore, it is no longer necessary for the individuals to wait to interact physically in order to understand the actual situation of a destination that they wish to travel to. It is now possible through these social media sites to get e-word of mouth as references. It is also possible to access the visual impact of the destination on the social media sites. This makes taking a decision become easier and it also supports the decision-making process as which is the best offer for travelling to a particular destination (Mintel, 2013).

For those who were born between 1980 and 2000 (also known as the Generation Y or the Millennials or Youth), the usage and integration of the Internet technology and social media with their daily life activities are not a challenge as they have a natural boundary and understanding of how these technologies can affect and simplify their daily life, because they grew up with them. It is said that nowadays approximately 70% of youth regard shared online information or opinions from their friends as influential in their purchasing decision (eMarketer, 2014) and they do consider travel review websites with a high number of personal experience statements as influential on their travel plans (eMarketer, 2012). This is also reflected in the travel decision making process by youth as social media no longer stand for cultivating friendships only, but are also considered as an important information source to help them decide where to go, how to get there and at which particular accommodation they should stay.

In the tourism and hospitality literature, a number of studies already discussed how Internet technology influences travellers. For instance, Gretzel and Fesenmaier's (2009) study discusses how different technologies (e.g., online customer support, e-mail and online travel communities) are used throughout the three stages of tourism consumption process. Although substantial effort has been made on examining how Internet technology impact travellers, there is still a knowledge gap regarding the influence of social media on their intention to travel by travellers in general and youth travellers in particular. Despite increasing attention towards Facebook, research into this

social medium has mainly been devoted to aspects such as privacy and psychological traits (Hew, K. F.,2011;Stutzman, F, Capra, R., Thompson, J.,2011) This study focuses on the usage of social media by youth travellers and its influence on their behaviour intention to travel and how its affect their travel decision making.

LITERATURE REVIEW

Social media is a group of internet-based applications which build on the ideological and technological foundations of Web 2.0. It allows the creation and exchange of User Generated Content (Kaplan & Haenlein, 2010). Parr (2010) defines social media as the use of electronic and Internet tools for the purpose of sharing and discussing information and experiences with other human beings in a more efficient ways. Jantsch (2008) considers social media as the use of technology combined with social interaction to create or co-create value. According to Merriam-Webster dictionary, social media is the forms of electronic communication through which users create online communities to share information, ideas, personal messages and other content.

Dykeman (2008) regards social media defined as "the means for any person to: publish digital, creative content; provide and obtain real-time feedback via online discussions, commentary and evaluations; and incorporate changes or corrections to the original content" (Dykeman, 2008).The online encyclopaedia wiki defines social media as the media for social interaction, using highly accessible and scalable publishing techniques. Social media use web-based technologies to transform and broadcast media monologues into social media dialogues.

From all these kinds of definitions, it is not hard to identify three fundamental elements that support the existence and prosperity of social media that is content, communities and Web 2.0. Without the technology, social media is just an empty talk. The Web 2.0 technology enables people to use various platforms to share, discuss and create contents with each other in the community. Nevertheless, technology becomes meaningless by itself unless people employ it to create value. From this point of view, communities, content and Web 2.0 are complementary and necessary to each other.

Today's young generation enjoys travelling more than any generation before. The increasing purchasing power and spending behaviour of young people has made this demographic an attractive target for different industries. It was estimated that 20% of the 940 million tourists travelling the world in 2010 were young people (UNWTO, 2011). By 2020, there will be around 300 million international youth trips per year, which represent a 59% growth in 10 years. According to the UNWTO report, the average youth traveller spends a total of $2600 per trip as compared to the average international tourist spends an average of $950 (UNWTO, 2011). This indicates that youth travel is one of the fastest growing markets in the tourism sector. The youth, especially the student segment, though deemed as more price-sensitive yet they have ample time to travel (Grigolon, Kemperman & Timmermans, 2012). In addition, Huang and Petrick (2010) stated that young travellers aged between 18 and 25 years are expected to be very influential.

Finding information for travelling purposes is an important part of making travel plans and it is one of the first steps of the decision-making process in order to reduce the risk of using unfamiliar services or of travelling to unfamiliar destinations (Nusair et al., 2013). Travelling can be divided into three phases: the before visiting phase, the during visiting phase, and the after visiting phase (Lim, 2012). During all these phases, travellers seek, use, and share information using different sources. Becoming a traveller is a self-learned process. According to MacCannell (1999), "touristic information is found in guidebooks and travel writings, but it is more thoroughly diffused throughout the

modern world than in the case for some other types of information". In the westernized world, with the development of Internet and social media, we have a real time access to the same information around the world. Generation Y members are able to follow the same trends, music, fashion, news, etc. around the clock and 365 days a year. This goes also for travelling and for seeking travel information.

Furthermore, travel decision making is a process that involves several stages (See Figure 1). Motivation to travel is the starting point in the travel decision-making process, followed by information collection, and assessment and elimination of destination alternatives. Once travellers have this information, they choose a destination, and participate in the actual travel. Finally, after travel is completed, travellers evaluate their satisfaction with the destination choice, and this evaluation will then influence future motivation for travel (Mansfeld, 1992). This study focused mainly on the first stage in this process, travel motivation, and secondarily on information search. The study examined travel motives, methods of information search, and helpfulness of various information sources, as reported by independent youth leisure travellers.

METHODOLOGY

The quantitative approach was employed to pursue this research. The design employed was the cross-sectional analysis, as we collected the data at one particular time. The population of this research is the youth travelers and the unit of analysis of this study was individuals who are Facebook user. The sample size for this study is calculated by using DeVaus proportion approach which is suitable for convenience sampling. We distributed 400 questionnaires using a non-probability sampling technique

A total of 388 youth travelers responded to the questionnaire. The criteria for the selection as the participants are that the age is within the range of 18 to 38 years old. The descriptive and frequency analyses were performed to analyze the profile of the data. The result showed the female (61%) outnumbered the male (39%) respondents. To analyze the data, we performed SEM- PLS analysis to test the model fit of the data and explain the influence of social media in travel decision making for youth travelers

FINDINGS AND ANALYSIS

Testing a PLS-SEM model on the data, we followed the two-step of assessment procedure suggested by Chin (2010). Firstly, the study evaluated the measurement model's assessment criteria, which include the reliability and validity of the constructs in the model. Secondly, we examined the structural model and the significance of the relationships between the factors. Figure 1 below presents the model tested for this study.

The assessment of the structural model deals with the relationships between constructs. This section explains the analyses of the direct relationships of this study. Table 1 shows the summary of the hypotheses for direct relationships.

N		Hypothesis statement
H1	Perceived Usefulness→ Travel Decision	There is a significant relationship between perceived usefulness of social media platform and youth travel decision.
H2	Perceived Ease of Use →Travel Decision	There is a significant relationship between perceived ease of use in information quality of social media and youth travel decision.
H3	Safety and Security Presence →Travel Decision	There is a significant relationship between safety and security presence of social media's information quality and youth travel decision.
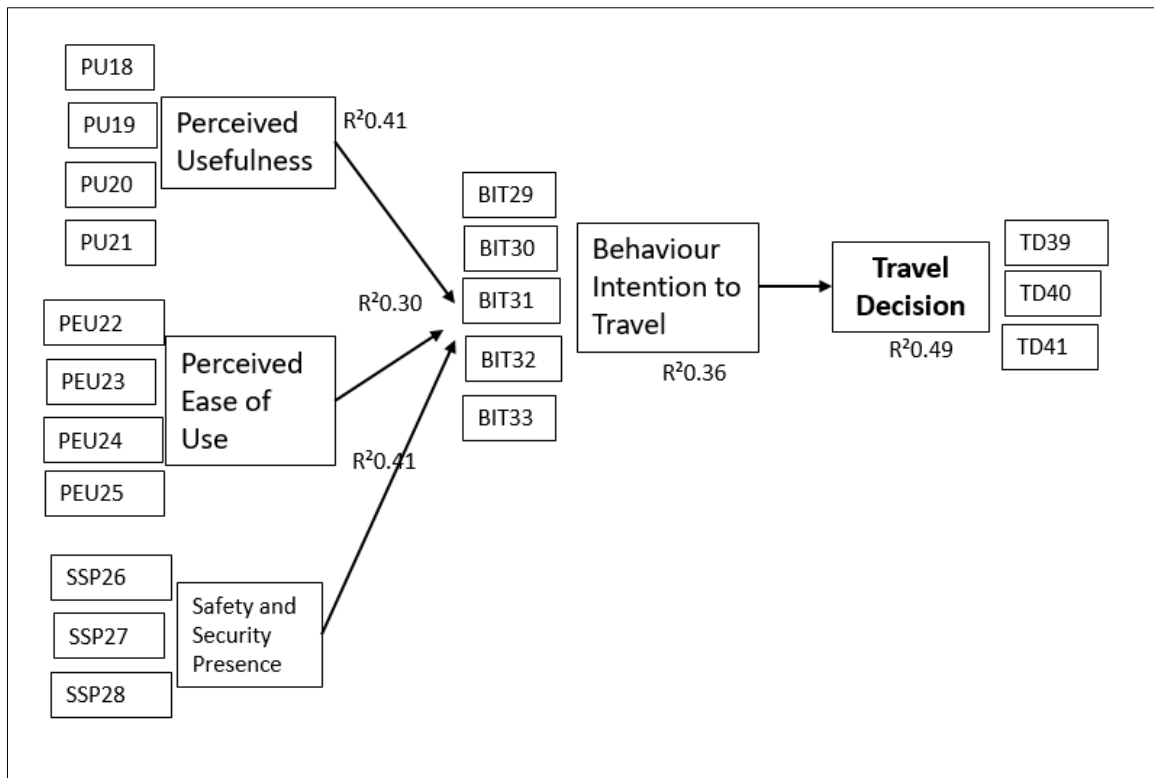
Hypotheses	Relationship	Path Coefficient (β)	Sample mean	Standard deviation	T-value	P-value	Result
H1	PUF→ TD	0.17	0.172	0.036	4.666	0.000	Supported
H2	PEU→TD	0.228	0.229	0.037	6.256	0. 000	Supported
H3	SSP→TD	0.208	0.208	0.037	5.554	0. 000	Supported

Based on data collection and tests that have been carried out by researchers, it was found that the youth travellers respondent data were 388 people, The main motivating factor for this generation to travel is mostly to undergo personal development experiences. In line with previous research from Sofronov (2018) entitled states that the millennial generation is the generation that has the most purchasing power for years. In the tourism sector, it must also pay attention to market segmentation, especially segmentation based on age, according to Schiffman and Kanuk (2015), "age is a potential market segment in tourism because every age has different travel needs." Age is also a major factor for tourists in choosing tourist destinations

because Malaysia has a very large population of young people and most of the Young people have a greater potential for travel because the younger generation has bigger relationships, more knowledge about tourist attractions and more actively seeking information about the latest tourist attractions.

This study uses the independent variable (Perceived Usefulness), based on the respondent's answer to each statement of this variable, states that perceived usefulness has a positive and significant effect on the travel decision

This study uses the independent variable (Perceived Ease of Use) , Based on the respondent's answer to each

statement of this indicator, it states that perceived ease of use has a positive and highest significant effect on the travel decision-making proces compared to the other independent variable (safety and security presence).

The main findings of this study indicated that youth travellers value the perceived usefulness of social media for knowledge seeking, and this leads to their intention to visit a destination. The findings also revealed that youth's perceived ease of use, perceived usefulness as well as

safety and security presence are all positively influence the behavioural intention of their travel decision making.

CONCLUSION

The main findings of this study indicated that youth travellers value the perceived usefulness of social media for knowledge seeking, and this leads to their intention to visit a destination. The findings also revealed that youth's perceived ease of use, perceived usefulness as well as safety and security presence are all positively influence the behavioural intention of their travel decision making.

The study contributes to the literature of tourism on role and influence of social networking sites like Facebook among youth travellers for their future travel. The purpose is to encourage the use of social media in the tourism industry. The target population for this study is youth social media users; a population that has been underrepresented in research studies. The results will offer a better understanding of the role of social media in influencing the travel decision making among youth travellers. Besides, there is a strong need for researchers in tourism studies to gain more understanding on youth tourists as the new trend for market segmentation in the tourism industry in the future. On the application level, tourism operators can decide and develop new marketing strategies to target more youth tourist especially through social media and develop new specific products to meet the demand of this special market segment. Comprehension of the decision making to travel among youth travellers in relation of social media when in travel planning process can help marketers to predict customer needs and market trends for this special segmentation to provide better service with the use of social media.

This research makes three contributions to the knowledge. First, the tourist behaviour theory by proposing information exchange as an enlarged tourist behaviour construct especially influence by the type of generations. Second, to relate the social

media with the travel decision behaviour by identifying specific medium and what factors that contributes specific decision-making process. Third, by proposing the social media decision-making framework to understand the usefulness and impacts towards tourism destination choices and the creation of a competitive strategies from the industries to target the special segment of youth generation.

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SYSTEMATIC REVIEW OF URBAN MANAGEMENT IN THE CONTEXT OF LIVEABILITY AND SOCIAL EXCLUSION IN NIGERIA

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ABSTRACT

Nigerian cities have some of the lowest liveability indices worldwide due to environmental degradation exacerbated by the remarkable expansion in the country's urban population. Various studies have revealed links between city liveability and urban management, indicating the urban challenges faced by Nigerian cities are due to fundamental flaws in city management systems designed to exclude critical urban actors. Therefore, this paper examines the nature and impact of city governments' urban management systems (U.M.S.) on inclusivity and liveability in Nigeria. Based on an extensive literature review, the paper notes that incorporating urban management under local governments (typically urban and rural settlements) redirects attention from urban centres resulting in their current problems. Additionally, the performance of municipal administration in Nigeria has been impacted by the exclusion of critical urban players from city management. Therefore, the article urges reviewing the current urban management paradigm and advises investigating cutting-edge strategies to reposition urban management in Nigeria.

Keywords : Local government, environmental problems, urbanization, administrative governance

INTRODUCTION

Urbanization is a significant problem for urban managers, particularly in Nigeria, where the population soared from 17.5% to 51.2% between 1969 and 2019 [1]. The Nigerian narrative on urbanization primarily focuses on numerous concerns, such as the growing prevalence of unfavourable urban environmental results and urban managers' failures to address the root causes. The demand for public and social services may considerably expand when urban populations proliferate. Social inclusion may be hampered by unequal access to housing, healthcare, transportation, and other essential services. Current statistics indicate that significant socio-economic disparities exist across the urban space in

Nigeria. The data suggest that numerous urban residents lack access to important services and supplies [2, 3]. For example, the poor, middle, and rich urban dwellers lack access to quality housing, social amenities, and public services [1].

According to recent estimations, most of Nigeria's urban population comprises poor people, who are consistently the most at risk of social exclusion. This group is most susceptible to various low development indicators, unemployment, poverty, and deplorable living conditions [4]. High social exclusion rates result from a lack of opportunities, particularly for urban poor, underserved, and vulnerable groups [5], which invariably affects effective urban management. Social exclusion includes the absence or rejection of rights, resources, products, or services. It is also the incapability to partake in socio-economic, cultural, or political activities and relationships accessible to most other individuals. According to Levitas, Pantazis [6], this scenario can impact people's quality of life, cohesion, equity in the community, and, more importantly, urban liveability. Liveability includes the features of urban settings that enhance the attractiveness of living spaces. These are categorized into perceptible structures, such as access to public infrastructure or imperceptible structures, such as local identity, social networks, and sense of place [7]. Typically, liveable cities are beautiful, clean, safe, affordable, and vital economically. Hence, such cities are characterized by efficient administration and functional infrastructure. These ensure the availability of effective public spaces, transportation, employment opportunities, cultural centres, and a communal sense of belonging [8]. According to various studies in the literature [9, 10], the state of the urban management system in Nigeria has caused liveability challenges. For instance, there is an uneven delivery of rudimentary public amenities such as public transport, sewage or drainage systems, waste disposal and management. Therefore, such amenities in one city region may result in their deficiency or absence in other parts [11]. Similarly, it is common for some cities to experience overcrowding, problems such as high air and water pollution rates, or insufficient maintenance of storm drainages. These challenges pose grave health and safety risks and aggravate susceptibility to flooding in nearby communities [12].

Urban environmental deterioration and a high rate of increasing urban population have intensified, placing Nigerian cities among the lowest liveability indices worldwide [12, 13]. Numerous urban problems in Nigerian cities suggest an underlying weakness in their management structure, as shown by studies linking urban liveability to the management of urban regions [14, 15]. The mobilization, diffusion, and involvement of all important urban players in public decision-making processes are essential for effective government [16, 17]. Therefore, this paper explores Nigeria's urban management system (U.M.S.) to establish the level of inclusiveness of city governments and its impact on city life.

URBAN MANAGEMENT ISSUES AND CHALLENGES IN NIGERIA

As stated earlier, many Nigerian cities are experiencing rapid urbanization. For instance, most of Nigeria's urban areas, such as Lagos, Ibadan, Abuja, Kano, and Port Harcourt, struggle [18]. This section chronicles the significant issues and challenges resulting from accelerating urbanization in the

country.

High Crime Rate

Urban crime rates and severity are sharply rising in Nigeria's many rapidly expanding cities [19]. The Global Peace Index posits that Nigeria is ranked 17th among the least peaceful nations in the world. Additionally, the nation is ranked the 3rd most afflicted by acts of terrorism according to Global Terrorism Index published by the Institute for Economics & Peace (I.E.P.) [20]. Similarly, Nigeria is the 2nd and 6th country with the most significant threat of genocide (mass killing) in Africa and worldwide [20]. While insecurity is a global issue, violent crime has been a problem in Nigeria since immemorial. But the rise of Boko Haram and other terrorist organizations has destabilized the nation. Acts of terrorism, banditry, kidnapping, murder, armed robbery, and ethnoreligious conflicts have therefore swept through Nigeria's urban and rural environments [21]. According to estimates, Boko Haram killed 58,562 people in Nigeria between 2011 and 2020, with the North-East states reporting the most significant death tolls [22].
Additionally, banditry, a Boko Haram spinoff, is wreaking havoc throughout the North-West and has claimed the lives of 235,723 individuals [22]. Beginning in the North-West, kidnapping has successfully spread throughout the entire nation. Kidnapping has resulted in 31,230 deaths, 821,000 abductions, and ₦8 billion paid in ransoms [19]. The same applies to armed robbery, assassinations, rape, burglaries, ethnoreligious disputes, and political violence [23]. As reported in [24], lack of good governance, prevalent poverty, and social imbalance in cities causes people to explore alternative means (such as violence and organized crime)

to sustain their livelihoods. Studies on the correlation between inequality and urbanization indicate disparities in areas such as wealth and education result in high rates of criminality [19, 23].

Mobility Problem

The urban transportation system is affected by rapid urbanization as well. Over the past two decades, an increase in commercial motorcycle riders and motorized two-wheelers has dramatically exacerbated and clogged the traffic mix, resulting in many city accidents [25]. Although walking and cycling are ordinary in several cities, walkers and cyclists in Nigeria are the most commonly wounded or killed in accidents. This may be partly attributed to poor road conditions and the low helmet usage rate estimated at < 5% [26]. Babalola [27] reported that 70% of all roads in Nigeria are in disrepair, whereas just 30% are in good condition. Furthermore, the infrastructure measures in many Nigerian cities primarily focus on road construction, which results in higher motorization, congestion, air pollution, stress, noise, and accident rates.

Housing Shortage and High Rate of Slum Formation

Since the 1960s, many cities in Nigeria have experienced significant housing deficits. The intrinsic flaws in previous policies and programs have aggravated the housing challenges. For example, the percentage of completed and allocated 202,000 planned housing units from 1975 to 1980 was below 15% [28]. Similarly, only 19% of the 200,000 new housing units earmarked for construction from 1980 to 1985 were accomplished [28]. According to Adeshina and Idaeho [29], the total

housing requirements in Nigeria between 1960 and 1970 were 2,380,000, which soared to 5,591,000 from 1970 to 1980. However, major cities such as Lagos, Onitsha, Enugu, and Port Harcourt have high rate occupancy, i.e., 3 persons per room on average [30]. According to the Vision 2020 report, the nation's annual housing requirements are between 500K to 1 million houses [31]. Despite the economy's growth in recent years, its impact on delivering the nation's housing needs remains low. These challenges are exacerbated by the current and incessant incidents of collapsed dwelling structures, loss of lives and property in many urban areas nationwide [32].

Therefore, several residential units in Nigerian cities are unfit for human habitation, which comes against the backdrop of the nation's numerous housing policies. For example, policies such as the National Housing Policy (1980), National Urban Development Policy (1997), and National Housing and Urban Development Policy (2002) were precisely promulgated to address the quantitative housing demands of Nigerians through mortgage finance [33]. However, the outlined policies are prone to weak organizational and inconsistent planning structures caused by the excessive politicization of implementation [29]. Furthermore, the wanton construction of make-shift and or permanent residential accommodation has expanded shantytowns in numerous cities [18]. Consequently, one of the biggest challenges to city governance is limiting the arbitrary placement of houses and other physical constructions.

Drinking Water Shortage

All facets of human growth depend on the availability of clean drinking water.

However, a severe and widespread water shortage in many Nigerian cities mainly impacts the urban population. In many cities, water quality through pipes is typically not guaranteed. When available, the water available in households or supplied via public taps is highly turbid with sediment [34]. For instance, only 3% of Ibadan people have access to pipe-borne water, compared to only 9% of Lagos' 10 million population.

Similarly, the survey notes that 76% of Nigerian families lack access to better drinking water [1]. The most popular source of improved drinking water accessible to 44% of residents of Nigerian cities is borehole or tube-well water [1]. However, this scenario varies across the nation's states and geopolitical zones. For example, street water vendors account for 37% of the water supplied to urban residents or households in Lagos, whereas water tankers account for 3% [18]. These practices negate the Federal Government of Nigeria's policy to provide 112 L of pipe-borne water per capita per day for all gazetted cities [1].

Sanitation

The state of sanitation in many Nigerian cities is entirely inadequate. Bassey [35] states that the fraction of homes equipped with modern or unshared washroom amenities are limited to 42.7% in Nigerian cities. This scenario suggests that open urination and defecation are commonly practised among many urban dwellers, which pose grave health and safety consequences in densely occupied cities. No city in Nigeria has a modern central sewerage system (CSS) [35]. Aliyu and Amadu [18] examined the percentage of homes with CSS connections in the 4 major Nigerian cities of Ibadan, Lagos, Onitsha, and Kano. The results showed that

connectivity to CSS is deficient but varied from 0% in Ibadan and Onitsha to 2% in Lagos and 3% in Kano. Likewise, the study noted that less than 1% of wastewater undergoes treatment in the major cities examined. Hence, the state of sanitation will worsen with the rapid growth in urban populations. The absence of effective municipal solid waste (M.S.W.) disposal and collection systems in practically all urban regions' squatter or slum zones is another issue [10]. Without exception, municipal authorities have failed to effectively handle the disposal and management of M.S.W. generated due to inadequate funding. According to Dipeolu and Ibem [36], there are several reasons for many Nigerian cities' water, sanitation, and hygiene crises. Significant factors include poor national planning, governance, and political willingness.

Additionally, inadequate knowledge, exacerbated by the poor maintenance culture, ensures the ineffective use of existing systems. Others include the ambiguous allocation of responsibilities between the private and public sectors, which creates lack of capacity to tackle such societal problems. Furthermore, the lack of prioritization of WASH (Water, Sanitation, and Hygiene) activities in the national budgets or donor funds is another critical factor.

Growing Environmental and Social Impacts of the Informal Sector

Urban government is now seriously concerned about how the economic dynamism of the informal actors is affecting society and the environment. Besides the challenges of providing appropriate sites for M.S.W. disposal, municipal administrators are also worried about enforcing waste management principles, notably

encouraging city residents to use the designated rubbish dump sites. It has become highly challenging to individually trace houses, street vendors, craftspeople, and even industries that dispose of their waste in violation of the law. Additionally, the environment is severely degraded by different pollution levels, including carbon dioxide emissions from automobiles. Other sources include carelessly disposed waste, poultry farm stench, and noise from amusement stands. These pollutants pose severe health and safety risks, which could lower the quality of life for city residents. Controlling the random placement of industries, street trade, hawking, and other indiscriminate economic activity is significant for municipal governance.

Persistent Unemployment

Large-scale unemployment in Nigerian urban centres is due to the country's rapid population agglomeration, especially among the economically active population segment, without concurrent growth of the urban economy. Urban administrators face challenges in creating an atmosphere that allows the informal sector to hire or offer employment prospects for this demographic. When unemployed for extended periods, young people feel pressured to turn to criminal activity to make ends meet, potentially adding another layer of social challenges for the government to address. Accordingly, it is crucial to assess the urban government system to establish its level of inclusion, which could contribute to the creation of liveable cities. This is particularly important given the myriad problems dogging Nigerian urban centres and the seeming inability of urban administrators to address them.

URBAN MANAMENT SYSTEMS (U.M.S.) IN NIGERIA

The legal framework founded by the Federal Government of Nigeria governs urban management in the country. According to this framework, cities are linked to larger regional and national contexts. Due to this, the legislative framework that governs the classification and sizing of cities in Nigeria can highlight U.M.S. The legislation that regulates U.M.S. in Nigeria includes the Guidelines for Local Government Reform (1976), the Urban and Regional Planning Act (1992), and Constitution of the Federal Republic of Nigeria (1999) [3, 31, 37].

Guidelines for Local Government Reform (1976)

In Nigeria, there are three government levels: Federal Government (based in the Federal Capital Territory, Abuja), the 36 State Governments, and 774 Local Government (L.G.) Areas. However, municipal boundaries are not considered when classifying the local administrations. Nigeria had several local government systems before and after independence since, according to the 1951 Nigerian constitution, L.G.s were made into regional or state subjects [38]. The L.G.s functioned under a system that did not promote the development of local projects or include relevant local stakeholders and lacked sufficient manpower and financing. Hence, the regions did not exercise significant autonomy [17]. The Local Government Reform of 1976 was a significant attempt to address such issues. As a result of the reform, the Federal Government of Nigeria acknowledged L.G.s as the 3rd-tier of government, below state governments [39]. With the reform, L.G.s gained the resources, personnel, and institutional framework necessary to launch and deliver pertinent services to their people. The L.G.s were also expected to obtain funding to promote grassroots growth [40]. Further reform goals include promoting local public engagement and providing basic infrastructure and services at community/local levels [41].

The Local Government Reform (1976) states that L.G.s are institutions designed by State governments to deliver essential services, community engagement, and develop grassroots by serving as the bridge between the community and the government [42]. According to paragraph 10 of the National Guidelines for L.G. Reform (1976), no town or city shall be divided between two Primary Local Governments, regardless of population. A single primary local government governs any town's whole planning area. This should apply to locations that are already formally constituted as Planning Areas and those that are anticipated to do so within the following ten years. When two or more towns—contiguous or not—are nevertheless close to one another to form a conurbation, the entire area should, with the planning peripheries, be in the same Local Government Area [43]. In 1985, a study of local government activities was conducted after that. When two or more towns, whether adjacent or not, are close to one another to form a conurbation, the entire area should be in the same Local Government Area, including the planning peripheries [43]. In 1985, a study of local government activities was conducted due to the reform [43]. The study established some standards for the makeup and functions of local governments, including the need for change every ten years, a population of at least 100,000 to 150,000, 20,000 tax-paying citizens, geographical proximity, long-standing ties to the community, and financial stability [43]. These standards contradict the ones put forth in the Local Government Reform Guidelines of 1976, which recognized the need to respect city boundaries and population density while establishing urban Local Governments. The abuse of turning metropolitan areas into several Local Governments across the nation has its roots in the lack of consistency in the criteria used to establish local governments. The study recognized some standards for the configuration and functions of LGs, including the need for

change every 10 years, a population of at least 100K to 150K, tax-paying citizens numbering 20K, as well as geographical proximity, long-standing community ties, and financial stability [43]. The standards refute the versions proposed by the LG Reform Guidelines (1976), which recognized the need to respect city boundaries and population density while establishing urban LGs. The wanton conversion of metropolitan areas into several L.G.s nationwide has its roots in the lack of regularity in the criteria employed to establish them. Large cities were split into two or more urban local governments, and some local governments comprised numerous towns and other smaller villages. One of the issues in managing cities for liveability is their fragmentation. When multiple governments were in charge of a city, differences in the availability of infrastructure and other diverse problems with urban management were evident. A further consequence of fragmentation is that municipal governments face a shortage of funding for effective urban development programmes.

Urban and Regional Planning Act (1992)

One law affecting Nigeria's urban governance is the Urban and Regional Planning Act of 1992. Its primary goal is to strengthen the land use planning and development control capacities of the 3-tiers of government. The Act calls for establishing a Federal level Commission to handle Federal matters to accomplish this goal. However, the Local Planning Authority is under the purview of each LG area council nationally, whereas the Board at the State government level is responsible for all state issues [31]. The nation should have a Commission, 36 Boards, and 774 Local Planning Authorities.

The Act prioritizes developmental control to create a more liveable urban environment. First, it suggests creating a multidisciplinary development control department with expanded authority to accept or reject development proposals from all sources, including government agencies [44]. Second, it aims to implement several development control procedures and orders against negligent developers. Thirdly, it seeks to carefully consider the significant environmental effects of development projects to stop environmental decay and degradation [44]. By encouraging public participation in physical planning to enhance acceptability and support for planning decisions, the Act also emphasizes social engagement in managing the physical environment of metropolitan regions.

Constitution of the Federal Republic of Nigeria (1999)

Nigeria has had numerous constitutions throughout its independent history. Federalism is a political system that divides legislative power between a federal/central administration and various regional (i.e., state, provincial, or local) governments. It is a prominent feature of the enacted 1999 Constitution of Nigeria [40]. Governmental authority in the Nigerian political system is divided between the federal, its component states, and, indirectly, LGs. By categorizing the responsibilities or activities of the central and component governments, the Constitution establishes the roles of these levels of government [37]. Due to this, there are typically three types of legislative lists that outline the duties expected of the various levels of government and the issues they can legislate on per the Constitution.

The first is the exclusive legislative list that involves duties uniquely delegated to the Federal tier due to their national scope. The second is the concurrent list that plans the duties or authority that the Federal and State governments may exercise, with the warning that Federal law takes precedence in the event of conflicting interests. The final section is the residual list, which includes duties or authority carried out or legislated at the State government level [37]. The local

administrations are subordinate to the State governments under this setup. They are in charge of their creation and have the authority to assign tasks or execute powers on behalf of the populace. However, The Federal government is only permitted by law to establish or control LG within its own boundaries [45].

A local government council's duties are listed in the 4th schedule of the 1999 constitution as follows: "(a) the provision and maintenance of primary, adult, and vocational education; (b) the development of agriculture and natural resources other than minerals exploitation; (c) the provision and maintenance of health services; and other functions conferred on the LG council by the State House of Assembly" [37]. The Revenue Mobilization Allocation and Fiscal Commission (RMAFC) has additional authority under the 1999 Constitution to distribute funds among the three tiers (Federal, State, and Local) of government. The RMAFC is a body established by the 1999 Constitution of the Federal Republic of Nigeria to maintain the Federation account and allocate the accumulated incomes to therein among the three tiers of government. Section 160, Subsections (2) to (4) of the Nigerian Constitution establishes the constitutional foundation for distributing money among the three tiers of government (8). Any funds remaining in the Federation Account will therefore be disbursed to the Federal, State, and Local Government Councils in each state by the terms and procedures specified by the National Assembly.

The monthly statutory contribution of the 774 LG councils funds infrastructure improvement so that the general public can feel the impact of the various tiers of government. By starting and attracting development projects to the local government councils, LG councils can also raise money to better the lives of people living in their service areas [41]. Local government councils can operate as public businesses and spend significant money on essential services overseen by elected and appointed officials. Some of the fundamental services provided by LG councils in Nigeria in response to its citizens' immediate and pressing needs include sewer construction, fire protection, garbage collection, housing management, health care, transportation, water supply, and education services (primary schools).

The over-centralization and engagement of limited stakeholders in municipal management are distinguishing characteristics of this UMS. The Local Government Reform (1976) and the Urban Management Act (1992) stress public participation to increase acceptance and support for public decisions. However, empirical studies and casual observations have revealed that low citizen involvement in public decision-making still permeates the U.M.S. in Nigeria. Due to intense public acceptability of decisions and refusal to pay taxes by taxable urban inhabitants, efforts to govern urban centres to improve liveability are continually frustrated. As a result, the tax base for operations related to urban management is low. The majority of stakeholders in the urban sector are excluded from public decisions by the current urban governance institutions, which discourages inclusivity, according to earlier claims made by Ogbonnaya, Ogujiuba [46]. As a result, Nigeria's formal urban management practises significantly cut off from the country's culture, traditions, and traditional knowledge.

URBAN MANAGEMENT AND LIVEABILITY IN NIGERIA

The overall contribution of the urban environment to residents' quality of life or well-being is called liveability [47]. The physical conditions a person lives in and the frequency of their interactions with a specific location make up urban environments [48]. This will significantly affect residential life by eliciting a reaction of Happiness or unhappiness. The level of enjoyment and, consequently, liveability experienced by inhabitants in urban areas can vary based on each sub-component [49]. The three aspects of urban environments—accessibility, enjoyment,

and safety—identified by the Organization for Economic Co-operation and Development were used in this research to assess the quality of residential settings [50, 51].

According to Mouratidis [52], accessibility refers to the available physical amenities available in the community. If numerous amenities are easily reachable, residents will be happy with their neighbourhood. The degree of accessibility satisfaction has been recognized in multiple studies as a crucial element in improving liveability [53-55]. For instance, De Vos and Witlox [56] explained that liveability increases with access to commercial districts, government offices, and cultural venues. However, the data shows that most Nigerian cities have poor access to such facilities. One of the most urgent issues in Nigerian cities is a lack of infrastructure, as was previously mentioned in the literature [10, 57]. Similarly, most homes in large cities and towns lack access to power, sanitary toilets, or piped water. For instance, only about 50% of Nigerians have access to electricity (the urban poor are excluded), compared to 100% of Mauritius and Seychelles residents [58]. According to estimates across the country, 22.3% of the current urban housing stock is decaying or needs considerable repairs. Most of this deteriorating housing stock is located in urban slums, informal settlements, and other run-down residential areas that receive little attention from the government [59].

Satisfaction with a city's or region's natural surroundings is called pleasantness. Various arguments have been made that natural landscapes can significantly improve residents' quality of life by offering places for relaxation [60-62]. Therefore, the city region's liveability increases with citizens' contentment with the presence and use of green parks, and vice versa. Nigerian cities are among those with the lowest liveability indices worldwide, exacerbated by rapid environmental degradation rates. According to estimates, 70% of urban residents live in areas with deteriorated natural environments [63]. In particular, Nigerian cities lack appropriate urban parks and planned green open spaces. For example, Lagos's predicted green space to population ratio is only 81,000 per hectare [64]. This report explains why a 2017 study of four L.G. areas in Lagos concluded that, despite being a significant piece of green infrastructure, public parks are either insufficient, inadequately furnished, in bad condition, or slowly disappearing [36]. In Abuja, 82% of areas designated for parks and other green spaces are yet to be developed [65]. According to Ujang, Moulay [66], the degree of contentment with green parks is crucial to urban satisfaction. In many Nigerian cities, there is little concern for green spaces and urban gardens, which inevitably contributes to the decline of the city centres in the absence of rehabilitation efforts. Hence, new urban peripheries are created without substantial efforts to design green spaces [64].

Safety refers to a place's resistance to mishaps, such as fires or natural disasters, and criminal activity. It is marketed as a crucial component of any urban surroundings. According to numerous studies in the literature [56, 67, 68], Happiness in urban settings is strongly correlated with crime or accident rates. Both the frequency and seriousness of criminal activity have increased across many cities in Nigerian [20]. The prevalence of tiny and light weapons, high levels of social exclusion, economic inequality, and weak social cohesion in the country have all been implicated in this malaise [69]. In Nigeria, crimes like gang violence, armed robberies, theft, and other minor offences are nothing new, but terrorism is a severe and brand-new aspect of urban crime. In Nigeria, terrorist attacks between 2011 and 2021 resulted in 58,562 fatalities and nearly 4 million displaced people [70]. This situation has made many cities, especially in the country's North, even less liveable. There is also the issue of fire events in the slums of many cities. Between 2019 and 2021, Lagbaja [71] recorded 68 severe fire occurrences that resulted in 79 fatalities, with most of the fires occurring in the

slums and markets of major Nigerian towns.

URBAN MANAGEMENT AND SOCIAL EXCLUSION IN NIGERIA

When individuals or communities are denied access to the necessary services or regular components of life that others take for granted, this is called social exclusion. People or socially excluded areas risk getting encircled by numerous problems. For example, unemployment, weak skills, low earnings, poverty, substandard housing, high crime rates, bad health, and family dissolution. The denial of equal chances by some social groups to others results in social exclusion, which prevents people from participating in society's fundamental political, economic, and social processes [72]. Therefore, social exclusion is the deliberate and ongoing rejection of the fundamental rights of individuals to a decent life.

According to the Human Development Report [73], human rights are categorized into seven core freedoms. These rights include freedom from injustice; freedom from fear; freedom from want; freedom to a decent standard of living; space for the realization of one's human potential; freedom from fear; freedom from threats to personal security; freedom from participation, expression, and association; and freedom for decent work; free from exploitation. The realization of these fundamental rights must occur inside society. Therefore, the effectiveness of urban governance—how people and organizations, both public and private—plan and oversee the city's day-to-day operations—becomes essential. Thus, efficient urban administration requires cooperation among local governments, businesses, civil society, community-based groups, and district/neighbourhood associations. As noted by Azu [73], cities dedicated to upholding human rights and implementing excellent urban governance are more likely to guarantee equitable economic growth, infrastructural development, service delivery, and fostering social cohesion. Unfortunately, inclusion is lacking in most Nigerian cities. For instance, Nigeria's UMS ignores the informal sector, primarily characterised by the urban poor but remains the largest employer contributing 57.7% to Nigeria's gross domestic product [74]. Despite this, many municipalities have attempted to criminalize the informal small businesses and livelihoods in city centres [75]. This perhaps informed the assertion of Bassey [35] that most urban poor in Nigeria had been locked in intergenerational poverty due to sundry reasons, many of which can be traced back to a lack of good urban governance.

MANAGING CITY FOR EXCLUSION: THE CASE OF ABUJA, NIGERIA

Abuja has been meticulously built to feature well-kept lawns, empty streets, and structures that convey a nouveau African-centeredness to a global audience. The primary objective of Abuja was to create a national Federal Capital Territory (FCT) that would serve as a symbol of a united, independent Nigeria for the nation's divided, unequal social classes [76]. The reality of physical and economic isolation in the city persists despite this lofty objective. The average person is physically cut off from the inner city because they cannot afford the luxuries of inner city living due to high rents and a lack of inexpensive transportation options. The city centre, with its paved roads, streetlamps, regular power, ample water, infrastructure, and facilities, is where most wealthier citizens reside. However, due to their inability to afford the exorbitant cost of living in the city centre, more than 70% of Abuja's working population lives in run-down satellite towns [77].

Social Exclusion and Liveability Issues in the Management of Abuja

According to the original master plan, the FCT development authority must "create a housing policy and programme tailored to the demands of the Capital's population" [76]. Only the middle and higher classes have access to inexpensive homes in Abuja. Luxury mansions are situated away from common city neighbourhoods and adjacent to the National Assembly, demonstrating the master plan's support for income-based residential segregation. It appears the master plan aims to create an environment of cyclical exploitation by employing the urban poor as cheap labour to run and maintain the city as taxi drivers, sanitation workers, and janitors, among others, while physically excluding them from the city so they cannot profit from it or take part in its culture. Planning and management strategies in Abuja's outlying areas strongly emphasise exclusion and segregation. For instance, some satellite towns near Abuja were specifically constructed to house the personnel of various international corporations, such as Julius Berger and Shell. Even if the communities have terrible circumstances, only the workers of these businesses are given nice homes. Whether these poor neighbourhoods are liveable is brought up by the fact that individuals without jobs are left to fend for themselves.

Another way to prevent the urban poor from accessing the city is criminalizing informal trade. The FCT master plan allocates large areas for commercial operations, particularly on the sidewalks (average 7 to 12 m [78]. However, non-stationary business activities are not allowed in the FCT due to zoning regulations. For instance, the city administration ordered the informal vendors stationed around Banex Plaza in the city centre to leave the area to provide access and facilitate business operations for established commercial activity [79]. Although Nigeria's urban economy continues to be heavily dependent on informal street trade, neither the structural nor institutional plans for the capital city include it.

The underprivileged in the city are also denied access to and benefits from the metropolis because of restrictions on urban mobility. The street grid and transportation networks constitute a physical barrier to the town in the current city transportation arrangement. For residents of satellite towns trying to cross the core city on foot, the Murtala Mohammed and Nnamdi Azikiwe boulevards, the outer "ring roads" around the city, which were utilized as a planning technique to regulate urban growth, create a four-lane barrier. In practice, city administrators can choose when and how the urban poor enter the city thanks to the transportation system and strict policy enforcement. In 2006, the FCT Administration outlawed minibus and commercial motorcycle operations in the city. It replaced them with high-capacity buses to replace the minibuses as part of the new public transportation system [80]. The new transportation plan was adopted without a clear citizen consultation process, and it is well known that those it intends to serve will find it unreliable and unaffordable. The restrictions have unavoidably made it difficult for commuters from the satellite towns to get to work in the centre metropolis because they had to pay expensive transit costs.

In conclusion, Abuja's ambition to rival "global" Western cities in planning and governance has caused Nigeria to lose a significant portion of its populace by excluding the group the town intended to serve. Although Abuja's world-class appearance has been established and sustained by modernist architecture and strict growth controls, they have also created hurdles to access for most of the population. Although strong policy enforcement keeps an area safe and under control, it also causes difficulties for the urban poor, whose daily activities and social customs conflict with such policies. Planning and administration strategies are required to combat urban polarization and foster inclusive, cohesive Nigerian cities.

PROPOSED ADMINISTRATIVE MODEL FOR URBAN MANAGEMENT IN NIGERIA

If all inhabitants' needs, concerns, and realities are not considered, urban administration cannot be considered comprehensive, holistic, or sustainable. Urban governance must be based on thorough public consultations at all levels, be periodically reviewed, conveyed in plain language, be available to the public, and, ultimately, be people-centric. However, Nigeria's current UMS cannot be said to be people-centric or inclusive. From all indications, people are far removed from the management structure, and therefore, the grassroots-development philosophy of local administration has been defeated. This is evident in the poor infrastructure, growing poverty, insecurity, poor service delivery, and slow economic growth, among other challenges experienced in Nigerian cities, as highlighted earlier in this paper. It is, therefore, imperative to develop an appropriate administrative model that will foster the inclusiveness and liveability of urban centres in Nigeria. The proposed model is presented in **Figure 1**.

Nigeria being a Federation, the Federal Government should continue carrying out its traditional duties, which have regional and global implications. These functions include external security, foreign relations, fiscal management, and specific infrastructure (e.g., teaching hospitals, universities, interstate roads, rail services, airports, and seaports). In contrast, all the administrative bodies in the proposed system should work together to conduct internal security functions. The second-tier of government (i.e., State governments), should concentrate on creating higher-order infrastructure that affects the region, such as the construction of secondary and high schools, teaching hospitals, specialized hospitals, universities, and intercity roads, as well as other services that have an impact on the entire state.

Local governments should continue to fulfil their obligation to provide local communities with infrastructure and services. Services include waste management, urban planning, regional security, local road construction and maintenance. Others include the provision of elementary schools, provision of health centres and dispensaries, street cleaning, provision of sewerage, and other directly affecting local community services.

Within each local government region, a municipal administration should be developed for urban areas to provide the necessary infrastructure and services for the healthy growth of the municipalities. The study demonstrates how the current system, which includes local governments serving both urban and rural areas while still including major urban centres, surely contributes to the subpar delivery of municipal services. Furthermore, the proposed municipal administration should be a semi-autonomous body constituted by the LG. It should comprise technocrats, traditional rulers, opinion leaders, women associations, and community-based organizations, all of whom must be city residents. The ability to collect and spend money from local taxes should be granted to the municipal government. The administration should be subjected to minimal supervision by the LG.

A District Management Committee should be established as a liaison between the city government and the neighbourhoods for efficient municipal administration. The idea is that different parts of a city will be categorized according to reliable criteria, such as the concentration of specific industries, commercial activity, income level, and certain ethnic and religious groups, among others. The committee will gather data on each district's needs and then submit a report to the city administration for any required action. District committee members must be district residents, just like the municipal administration.

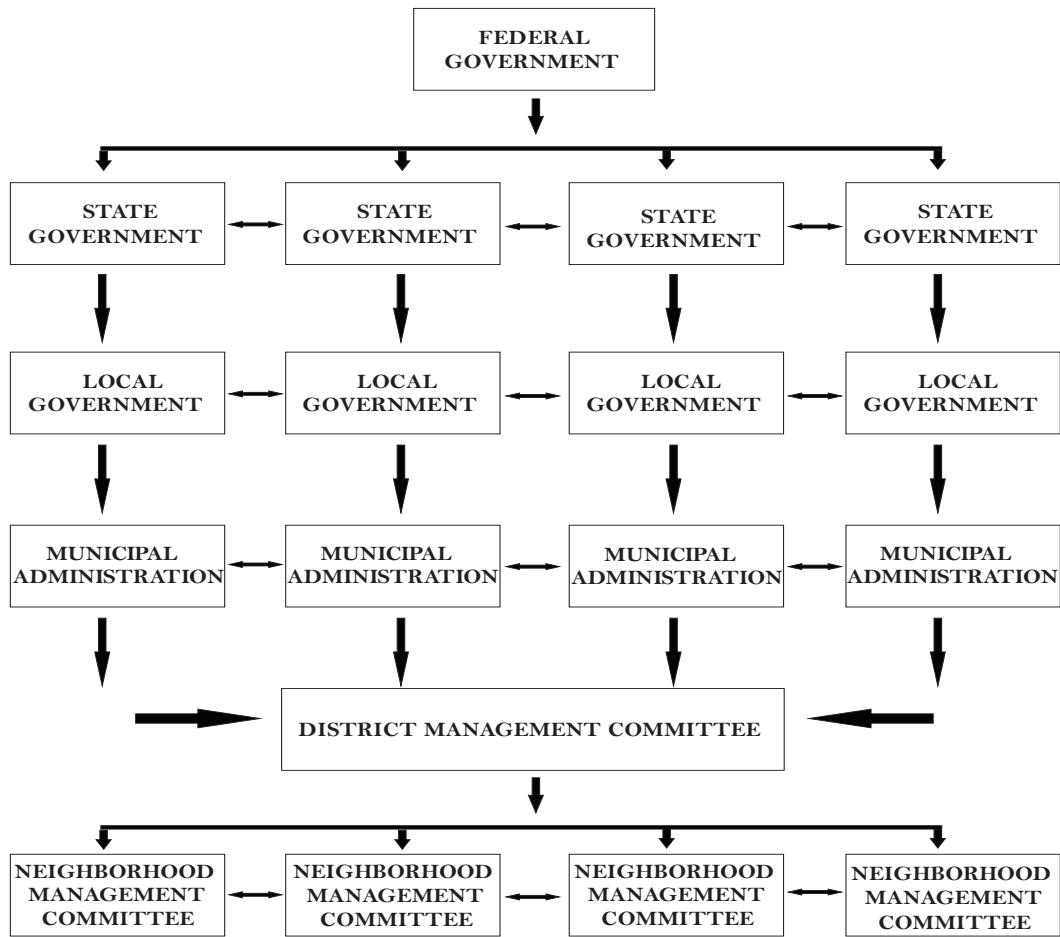The Neighbourhood Management Committee (NMC) is the last organization

Figure 14: Proposed Administrative model for Urban Management in Nigeria

on the ladder. The NMC will consist of the local landlord and community development associations, youth and women representatives, members from the informal economy, and other pertinent organizations. The security, roads, water system, drainages, sanitization, electricity supply, and other local services in the neighbourhood are all under the committee's control. The provincial government should regularly and sufficiently finance the committee and give it the authority to raise cash to deliver services effectively.

It is essential to underline the importance of the fiscal decentralization of power. This issue will enable LG councils to use various administrative agencies to offer critical services to their citizens. This will allow the provincial government to operate according to the needs and expectations of its people. Thus, there must be an effective transfer of intergovernmental resources among the various tiers of government. The State government should not exercise unnecessary control on the LGs, especially if they are autonomous. Lastly, there is a need to develop a good management capacity index to ensure periodic evaluation of local government, municipal administration, district committees, and neighbourhood committees.

CONCLUSION

If the needs and realities of every person are not considered, urban governance cannot be regarded as comprehensive, holistic, or sustainable. Urban governance must be based on extensive public input from many different angles. In addition, it must be presented in plain language and periodically reviewed. It must also be available to the public, and, most importantly, it must focus on its constituents' needs. If Nigeria doesn't reform, harmonize, and develop its urban governance structure, Goal 11 of the Sustainable Development Goals—sustainable cities and communities—cannot be fulfilled in Nigeria. A significant benefit of effective urban government is its

ability to moderate urban crime, environmental degradation, and homelessness and fuel Nigeria's economic growth push. Urban governance is expected to start and carry out social welfare programmes for city residents and establish job opportunities for sustainable livelihood. In addition, it must provide functional and well-planned housing settlements for various income earners to ensure a healthy environment. The existence of peace and order, complete and secure life and property of city residents are critical to creating a sustainable environment where no one is left behind. These require good governance and the cooperation of all relevant parties to deal with such growing concerns.

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