الجامعة الإسلامية العالمية ماليزيا
INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA
يونيورسيتي إسلام انتارابغسا ملسيا
(Company No. 101067-P)
Garden of Knowledge and Virtue

JOURNAL OF ARCHITECTURE, PLANNING AND CONSTRUCTION MANAGEMENT

VOLUME 14 ISSUE 2
2024

JAPCM

JOURNAL OF ARCHITECTURE, PLANNING AND CONSTRUCTION MANAGEMENT

Editor-in-Chief
Prof. *Ar.* Dr. Abdul Razak Sapian
Kulliyyah of Architecture and Environmental Design

VOLUME 14 ISSUE 2 (2024)

JOURNAL OF ARCHITECTURE, PLANNING AND CONSTRUCTION MANAGEMENT (JAPCM) TEAM 2024 – 2025

JOURNAL OF ARCHITECTURE, PLANNING AND CONSTRUCTION MANAGEMENT
VOLUME 14: ISSUE: 1/2024

Preface	**v**
COMPARATIVE ANALYSIS OF STORMWATER MANAGEMENT TECHNIQUES: CASE STUDY OF MALAYSIA, JAPAN AND THE NETHERLANDS *Ameera Nazeerah Ahmad Khairi, Zakiah Ponrahono, Syazwani Sahrir*	**1-13**
UTILISATION OF OPEN SPACES IN ENHANCING ARCHITECTURAL SUSTAINABILITY: A CASE STUDY OF METROPOLITAN LAGOS *Segun Okunola, Bola Ogunbodede, Akinfolarin Jobi*	**14-24**
UNDERSTANDING THE MULTI-FUNCTIONAL NATURE OF PUBLIC OPEN SPACE, A CASE STUDY AT KLCC PARK, KUALA LUMPUR, MALAYSIA *Muhammad Asyraf Aizat Bin Kapeli, Nurhayati Abdul Malek*	**25-40**
A STUDY ON CIRCULAR MATERIAL INFORMATION WITHIN SMALL AND MEDIUM ENTERPRISES IN MALAYSIA *Liew Yong Kian, Fadzli Irwan Bahrudin, Khalilah Zakariya, Shamzani Affendy Mohd Din*	**41-52**
KEPONG BOTANICAL GARDEN: THE ROLE AND CHALLENGE TOWARDS CONSERVATION PLANT DIVERSITY *Nur Nabilah Mohd Radi, Zainul Mukrim Bin Hj. Baharuddin, Jasasikin Ab Sani*	**53-68**
A GEOSPATIAL FRAMEWORK FOR SELF-SUSTAINING URBAN METABOLISM IN SOUTH TANJUNG DUREN AREA, WEST JAKARTA *Audrey Juliana, Adli Nadia, Doni Fireza*	**69-92**
A BIBLIOMETRIC REVIEW ANALYSIS ON ENVIRONMENTAL CONSERVATION IN ISLAMIC PERSPECTIVES: MAPPING TRENDS *Illyani Ibrahim, M Zainora Asmawi, Azila Ahmad Sarkawi*	**93-109**

THE BEST HEALTHY SPATIAL DESIGN REQUIREMENTS FOR PRESCHOOL CHILDREN IN CHINA *Maszura binti Abdul Ghafar, Zhou Yajing*	**110-122**
REVITALIZING KELANTAN MALAY TRADITIONAL ARCHITECTURE: THE ADAPTATION OF MALAY TRADITIONAL ARCHITECTURE DESIGN FEATURES IN KELANTAN TO MODERN CONTEMPORARY ARCHITECTURAL SCHEME *Nur Shafiqah binti Abdul Razak, Azmal bin Sabil*	**123-135**
EMERGING TECHNOLOGIES FOR MAINTENANCE MANAGEMENT OF RESIDENTIAL AND COMMERCIAL HIGH-RISE BUILDINGS: BARRIERS AND STRATEGIES FOR IMPROVEMENT *Muhammad Wafiq Mohd Sakhaf, Mohd Fairullazi Ayob*	**136-148**
COMMUNITY FISH MARKETS: DESIGN STRATEGIES FOR IMPROVED FUNCTIONALITY AND USER EXPERIENCE *Aina Shafira Basir, Nayeem Asif, Zeenat Begam Bt Yusof, Aliyah Nur Zafirah Sanusi*	**149-161**
THE PROFILING OF AL-ROZNAH IN OMANI INTERIOR DESIGN: FROM CULTURAL IDENTITY TO CONTEMPORARY LOSS AND REINTERPRETATION *Hadifi Wafaa Awadh Hamdan, Arita Hanim Awang*	**162-172**

Notes for Contributors

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors, and the reviewers. Any product that may be evaluated in this article, or claim that may be madeby its manufacturer, is not guaranteed, or endorsed by the publisher.

Published by

IIUM PRESS, Research Management Centre and Kulliyyah of Architecture and Environmental Design, International Islamic University Malaysia

ISSN 2231-9514
e-ISSN 2462-2222

PREFACE

السَّلاَمُ عَلَيْكُمْ وَرَحْمَةُ اللهِ وَبَرَكَاتُهُ

Dear All,

Journal of Architecture, Planning and Construction Management (JAPCM), Kulliyyah of Architecture and Environmental Design is one the official journals of International Islamic University Malaysia (IIUM), under IIUM Press. It embarked in 2011 and is dedicated to the publication of original articles on the specialized fields of Architecture, Planning, Landscape Architecture, Quantity Surveying, Building Technology and Engineering,Applied Arts and Design, Construction Management and those related to the Built Environment. JAPCM is also the ardent forum for the reports of research that bridged the Built Environment and the Islamic worldview.

Prof. *Ar.* Dr. Abdul Razak Sapian
Editor-in-Chief

JOURNAL OF ARCHITECTURE, PLANNING & CONSTRUCTION MANAGEMENT
Volume 14 Issue 2, 2024 E-ISSN: 2462-2222 ISSN: 2231-9514

COMPARATIVE ANALYSIS OF STORMWATER MANAGEMENT TECHNIQUES: CASE STUDY OF MALAYSIA, JAPAN AND THE NETHERLANDS

Received: 18 October 2024 | Accepted: 24 September 2024 | Available Online: 07 December 2024
DOI: 10.31436/japcm.v14i2.829

Ameera Nazeerah Ahmad Khairi[1*], Zakiah Ponrahono[2], Syazwani Sahrir[3]

[1] Department of Environment, Universiti Putra Malaysia, ameeranazeerah@gmail.com*
[2] Department of Environment, Universiti Putra Malaysia, zakh@upm.edu.my
[3] Department of Environment, Universiti Putra Malaysia, syazwani_sahrir@upm.edu.my

Corresponding author: **Ameera Nazeerah Ahmad Khairi*
The corresponding author's email: ameeranazeerah@gmail.com

ABSTRACT

Climate change and rapid urbanisation lead to the reduction of green spaces due to infrastructure development to meet the growing population's demands. As a result, the increase in impervious surfaces and inadequate drainage systems leads to flooding problems. As one of the tropical countries with heavy annual precipitation, Malaysia has gained attention for global warming issues. The purpose of the study is to analyse stormwater management practices in several developed countries, such as the Netherlands and Japan, compared to Malaysian practices. Case studies were extracted from the literature findings, allowing the adoption and utilisation of practices from developed countries in Malaysia. The research revealed that both case studies, Tokyo's G-Cans Project and the Netherlands' Delta Works, implemented several techniques that offer significant potential for flood mitigation projects in Malaysia. However, the data reveal that previous pavements, swales, and detention ponds serve as stormwater infrastructure in all three nations. Both developed countries have encouraged the implementation of green roofs, but Malaysia continues to face resource limitations and new exposure issues. The Malaysian government should contemplate expanding the number of monitoring stations to enhance data accuracy and emulate Japan's innovative use of artificial intelligence (AI) for future flood prediction. Current issues in Malaysia, such as sinkhole incidents and flooding, require the government to act efficiently and regularly monitor. In summary, Malaysia still needs to catch up in stormwater management and flood mitigation, necessitating the adoption of practices from advanced countries for improved future development.

Keywords: climate change, G-Cans Project, Japan, Malaysia, Netherlands, SMART Tunnel, stormwater management

1.0 INTRODUCTION

The United Nations estimates that more than 55% of the world's population currently resides in urban areas, with a projected increase to 68% by 2050 (Kumar et al., 2021). People have repurposed the abundance of urban green spaces for the construction of housing, industrial facilities, transportation networks, and various other urban infrastructure projects. Cities face mounting demands to adjust to swiftly evolving environmental circumstances and keep pace with socio-economic progress (Zhang et al., 2022). The shifting growth trend has led to an extraordinary rise in developed land due to population and economic growth. Urban expansion in Malaysia has increased by nearly 30–40% over the last three decades (Hasan et

al., 2019). The result has been an increase in non-porous land surfaces and insufficient drainage infrastructure, impeding the proper functioning of hydrological systems, ecological processes, and community well-being (Fang et al., 2021; Wu et al., 2021; Yang et al., 2021).

Cities are susceptible to water-related risks like droughts, water pollution, and flooding (Zhang et al., 2022). Urbanisation further alters the global water cycle due to climate change, leading to many water-related issues, including water scarcity and flood damage (Song, 2022). (Starzec et al., 2020) support this, stating that local urban flooding is an increasingly common phenomenon in densely populated areas. They are caused by heavy precipitation, whose intensity exceeds the capacity of municipal drainage systems to convey them hydraulically. Besides, increasing the composition and weight of urban litter are the primary environmental issues that demand attention. The blockage of drains and waterways results from unrestricted human activity, including the development of buildings near rivers and the unregulated disposal of debris (Mohamad Yusoff et al., 2018). Environmental awareness and societal views play a crucial role in this.

Over the past two decades, Malaysia has received considerable attention in environmental research, and its repercussions are due to its substantial rainfall patterns and warming (Tang, 2019). Flash floods are particularly worrisome for residents and workers in metropolitan cities such as Kuala Lumpur. In an urban area with a high population density where land adequate for holding water is limited, a flash flood is defined by poor drainage management during heavy rainfall (Misni & Shahfuddin, 2017). Moreover, the threat of flooding has caused more revenue losses than any other hazard affecting cities (Assaf & Assaad, 2023). Therefore, it is crucial to implement effective flood mitigation measures and stormwater management techniques in the country, as they not only enhance the ecosystem but also lessen the negative impacts on communities.

This study aims to identify Malaysian stormwater management practices and compare them to those of other countries, such as Japan and the Netherlands, with significantly better stormwater management practices. Due to its geographical location, which is prone to natural disasters, Japan is recognised for its use of advanced technology and better prevention. At the same time, the Netherlands is known for its flood management. The findings can be used as a reference to adopt or adapt best practices that suit the local context of Malaysian cities.

2.0 LITERATURE REVIEW

To prevent urban flooding, adequate drainage systems for collecting and transporting stormwater are required. The SWM concepts emerged as early as the 1960s, examining the quantity and quality of urban stormwater in response to land use and climate change (Bibi et al., 2023; Song, 2022). In 1977, the United States proposed best management practices (BMP) as the first preventive plan to describe a systematic strategy or practice intended to prevent pollution (Fletcher et al., 2015), and this progressively transformed other developed nations to utilise other stormwater management concepts such as Low-Impact Development (LID), Water Sensitive Urban Design (WSUD), Sustainable Urban Drainage System (SUDS), Best Management Practices (BMPs), Sponge City and Blue-Green Infrastructure (BGI). Nonetheless, all these concepts aid in managing stormwater to reduce surface water runoff sustainably. As previously mentioned, the study aims to compare the stormwater

management practices implemented in Malaysia and other regions, and the sub-section below will further explain the case studies.

2.1 Malaysia Urban Stormwater Management

Malaysia is a tropical country that experiences significant rainfall throughout the year. Inundations are the most prevalent natural disaster in Malaysia. Malaysia has encountered a variety of climatic and weather occurrences, such as El Nino 1997 and La Nina in 2011 and 2012, which resulted in severe droughts and floods, respectively. About 9%, or 29,800 km2, of Malaysia's landmass, is susceptible to flooding (Diya et al., 2018; Mohamad Yusoff et al., 2018; Saleh Dutsenwai et al., 2015).

Conventional stormwater management in Malaysia has been comprised of the rapid conveyance of runoff via the sewage system to prevent inundation (Abdul Khadir et al., 2023). The Malaysian government has published the Urban Stormwater Management Manual for Malaysia, or MSMA (DID, 2000), to acknowledge the necessity for a change in stormwater handling. This manual includes a particularly present innovation in stormwater management, the control-at-source strategy. According to MSMA 2nd Edition, control at source refers to the runoff quantity control requirements for construction or redevelopment projects of any size. "The post-development peak flow of any ARI at the project outflow must be below or equal to the before-development peak flow of the associated ARI". Effective in 2001, every new project in Malaysia must adhere to an amendment that mandates the use of sewage treatment devices or infrastructure to regulate the amount and the quality of stormwater runoff (Zakari, 2016). A new MSMA 2nd Edition manual was published by DID, which enforced the execution of Best Management Practices (BMPs). The manual offers a comprehensive guide to suggested procedures for resolving current obstacles and issues.

According to (Wan et al. et al., 2017), the Integrated Flood and Rainfall Management (IFFRM) is a fully automated system that operates by a combination of life, telemetered gauged data from the Department of Irrigation and Drainage's (DID) personal InfoBanjir database, spatial rainfall radar data, and Numerical Weather Prediction (NWP) rainfall forecasts from the Malaysian Meteorological Department. This system aims to aid in emergency response. About 335 telemetric rain gauges and 208 telemetric water level stations are installed throughout Malaysia (Muhd Zain et al., 2020). Additionally, the government, in collaboration with numerous agencies, has initiated the "River of Life" project, which concentrates on the Klang River, which spans the most intensely populated region (Yeo et al., 2023). The river encountered intensified inundation during storm seasons and became highly polluted due to accelerated development.

Furthermore, to control and remove stormwater in urban areas, Malaysia offers a diverse selection of gross pollutant traps (GPTs) specifically designed to catch litter during irrigation conveyance (DID, 2012; Malik et al., 2019). Detention ponds, on-site detention (OSD), perforated pipe systems, porous pavements, and infiltration utilities such as swales and trenches are among the Low Impact Development (LID) techniques that Malaysia has implemented (Misni & Shahfuddin, 2017; Sidek et al., 2006). Kuala Lumpur's Stormwater Management Road Tunnel (SMART) is an additional captivating stormwater infrastructure that effectively addresses flash flood issues. The city's most susceptible areas are protected from floodwater from the Upper Klang Ampang catchment by the 9.7km tunnel, which

consists of 30 hydrological stations, floodgates, a flood warning system, a retention pond, and a mitigation pond. The tunnel begins just before the meeting point of the Klang and Ampang Rivers (Azhar et al., 2021; DID, 2008; Ramly et al., 2020).

Fig. 1: SMART Tunnel in Kuala Lumpur City Centre
(Source: https://themalaysianreserve.com/2022/12/10/smart-tunnel-closed-in-preparation-for-flood-operations/)

According to the Economic Transformation Plan, DBKL intends to increase its tree planting initiatives to 100,000 trees, with a special focus on trees that provide broad coverage to give an appearance of green corridors (Kuala et al.– City Planning Department, 2024). Furthermore, the Malaysia Budget 2023 allocates RM15 billion for the Flood Mitigation Plan until 2030, which includes the construction of Sabo Dam, the establishment of a dual-function retention reservoir, and the National Disaster Management Agency's (NADMA) obligation to ensure preparedness in the event of flooding.

2.2 Japan Urban Stormwater Management

According to the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Japan is prone to natural disasters, including typhoons, earthquakes, and volcanic eruptions. As mentioned by (Uchiyama et al., 2023), Japan is bounded by oceans and has the world's sixth-longest coastline and twice as much precipitation as the global average. Approximately 70% of the land area is mountainous, and rivers are short and steep. Several studies have been carried out to investigate the impact of the subsequent flood events related to Northern Kyushu Heavy Rain in 2017, Western Japan Heavy Rain in 2018, and Typhoon Hagibis in 2019, which destroyed broad regions in Japan. This event has raised awareness about avoiding or reducing flooding losses.

The measurement of rainfall serves as the primary foundation for urban flood risk management, guiding the design of runoff management infrastructure, the preparation of evacuation plans, and the execution of numerical simulations. In 1974, the Japan Meteorological Agency initiated the Automated Meteorological Data Acquisition System (AMeDAS), an automated meteorological observation system, to observe regional meteorology and utilise the data for meteorological disaster preparedness (Shibuo & Furumai, 2021). The Tropical Rainfall Measuring Mission (TRMM) (Kummerow et al., 1998)and the Global Satellite Mapping of Precipitation (GSMaP) (Kubota et al., 2006) are examples of satellite-borne observations of rainfall. The possibilities for handling risks, especially flood prevention or identifying elevated water bodies, including floodplains, arise when satellite products are combined with rain gauges (Acierto et al., 2018).

Real-time prediction of the commencement and location of sinking areas is a significant challenge in urban stormwater management. Hence, in collaboration with the Tokyo Metropolitan Sewerage Service Corporation and Hinode, Ltd., Meidensha Corporation has created the "smart manhole cover" to address the ground-level area. Using the real-time water level information from a smart manhole cover results in early signs of pluvial flooding, ensuring the safe evacuation of the main underground area (Shibuo & Furumai, 2021).

Lastly, the G-Cans project (Fig. 2), the Tokyo metropolitan area's outer underground discharge channel, is the world's largest underground floodwater diverting facility and a well-known example of stormwater management in Japan. The project contains a storage tank with 78 pumps and five gigantic silos, as well as a 6.5 km-long connected tunnel (Bobylev, 2007; Chang et al., 2018). Modern remedies for comprehensive flood control are recognised, including rainwater retention such as swales, green roofs and infiltration as critical components (Saraswat et al., 2016).

Fig. 2: The G-Cans project's water storage tank is supported by 59 pillars and stands at a height of 25.4 meters.
(Source: https://www.water-technology.net/projects/g-cans-project-tokyo-japan/)

The engineering and scientific process of creating intelligent machines is known as artificial intelligence (AI). In recent years, there has been a significant increase in attention given to the potential of AI technologies for combating climate change (Jones et al., 2023). Japan is always one step ahead in flood mitigation. According to (UNESCO, 2021), the primary objective of Japan's Artificial Intelligence Technology Strategy is to "implement resilience-oriented urban planning through AI" in order to enhance the emergency response by decreasing the burden on disaster management agencies' staff in regards to gathering and analysing information and by offering early warning of a forthcoming catastrophe. AI systems can track flooding conditions and trace storms, preparing the public for these imminent catastrophes days or hours in advance.

2.3 The Netherlands Urban Stormwater Management

The Netherlands is located in the delta of the Rhine, Meuse, Scheldt, and Ems rivers, which run along the North Sea coast. The Dutch land lies approximately 26% below the normal sea level, and approximately 60% is vulnerable to flooding (Diakomopoulos et al., 2024). Since the 18th century, when the Dutch population began to expand swiftly, flood risk management has been a critical state concern for the Dutch people. The Royal Netherlands Meteorological Institute (KNMI) estimated that the sea level will rise by 0.35 m by 2035 and 0.65 m by 2070, which requires the city of Rotterdam to increase both the retention and detention capacity of its groundwater system (Francesch-Huidobro et al., 2017). A study from (Brouwer & Van Ek, 2004) highlighted that the critical situations in 1993 and 1995 in the Rhine and Meuse deltas, which threatened polders and required the relocation of tens of thousands of people, demonstrate the urgency of the inundation threat in the area.

In addition to raising dikes, the delta's future inundation necessitates implementing additional measures. The dikes mostly exceed the national standard (Xiong, 2021). The Room for the River program was designed to increase river capacity during high water levels (Mosselman, 2022; Verweij et al., 2021). Fig. 3 illustrates the Maestlantkering storm surge barrier to prevent flooding, which is managed by the Ministry of Infrastructure and Water Management (Rijkswatertaat).

Fig. 3: The Maestlantkering is a storm surge barrier and a vital part of the Delta Works
(Source: https://www.rijkswaterstaat.nl/en/projects/iconic-structures/maeslant-barrier)

The utilisation of Sustainable Urban Drainage Systems (SUDS) has increased (F. Boogaard et al., 2014). As part of a planning strategy, the proposed land use change and floodplain restoration measures aim to prevent the occurrence of new cycles of dike reinforcement, promote the creation of ecological diversity, and encourage the multipurpose use of land whenever possible. The function of floodwater retention is of utmost importance due to the potential hazards to life and livelihood caused by flooding, as well as the ability of floodplain wetlands to mitigate this risk. Land used as an excess water retention area ensures that no further developments, such as the construction of freeways or residential housing, will compete for the limited available space (Brouwer & Van Ek, 2004).

Additionally, (Birch et al., 2008) discovered several case studies in the Netherlands where the Leidsche Rijn implemented a comprehensive confined canal system that maintains water velocity by pumping water from lower to higher ground. The system directs the collected stormwater from roofs through downpipes, spouts, and small streets paved with permeable pavement, culminating in a 40-meter-deep lake on the northwestern edge of Leidsche Rijn, after traversing a network of wadis, also known as swales and canals. Furthermore, Culemborg's EXA-Lanxmeer has implemented local infiltration, effluent treatment, rainwater harvesting, and reusing. This method is supported by (F. et al., 2023) who stated that the Netherlands has mapped more than 1500 swales using the ClimateScan instrument. KNMI has set up various types of meteorological and hydrological monitoring facilities with 45 automatic weather stations, 320 voluntary observers, and seismometers and infrasound sensors.

Additionally, maintaining and strengthening existing infrastructure (dykes, barriers, and sewers) is necessary (O'Donnell et al., 2021). Thousands of green infrastructure projects have been implemented with grey infrastructure (F. et al., 2023). In order to protect the city from urban floods, Rotterdam implements a variety of indicators for stormwater adaptation resilience. These assessments include conventional engineering, water pipes, drainage pipes, progressed public facilities such as the water square (Fig. 4), and measurement regulations. Underground parking water storage is an approach that addresses the issue of urban water retention by utilising multipurpose space rather than utilising the urban environment directly (Xiong, 2021). Rotterdam has implemented various measures, making the city one of the most effective in the world at mitigating urban floods and waterlogging. In summary, the Netherlands is leading the way in encouraging BGI approaches, such as redesigning the city to increase water storage space and collaborating with other city initiatives to connect adaptation and spatial planning.

The Dutch government established statutory standards for flood protection structures, including dikes, dams, and other civil engineering structures established by the Water Act (soon to be the Environment Act). Every 12 years, the regional water authorities must conduct inspections to verify that the flood defences meet the legal standards. If the requirements remain unmet, the responsible entity may apply for funding from the Dutch Flood Protection Programme (DFPP). However, concurrent challenges exist, including improving the production rate (effectiveness) of flood defence projects and enhancing efficiency through lowering expenses per kilometre (Tromp et al., 2022).

Fig. 4: Rotterdam's first full-scale water square
(Source: https://www.dutchwatersector.com/news/new-innovative-water-square-combines-leisure-and-storm-water-storage-in-rotterdam-the)

3.0 METHODOLOGY

This study utilised case studies within the qualitative method framework as the primary research approach. The authors developed in-depth studies for each country based on our understanding of the stormwater management techniques used in various countries to mitigate floods, aiming to offer more effective recommendations for implementation within Malaysia. Comparative analysis was used to identify the countries' differences in flood mitigation practices. Comparative analysis primarily clarifies and improves comprehension of the causes and effects that contribute to forming an event, feature, or relationship. This analysis combines differences in the explanatory factor or variables (Pickvance, 2005).

In this study, the method of conventional comparative analysis was employed. According to (Grandgirard et al., 2002), where conventional comparative analysis is a subtype of analysis that satisfies two criteria: (a) Data must be collected from two or more cases. The unit's subject matter is arbitrary; these instances may be countries, cities, firms, or families; and (b) Try to offer an explanation rather than just a description. This study has conducted case studies from Malaysia, Japan, and the Netherlands to evaluate their approaches to mitigating flooding.

4.0 RESULTS

This section provides findings for a comparative analysis of three (3) case studies identified based on the established criteria. Various characteristics were compared, such as climate, challenges, exceptional flood mitigation projects, stormwater infrastructures, and other aspects. The table below presents the findings from the case studies above.

Table 1: Comparative analysis of stormwater management in Malaysia, Japan and the Netherlands

Characteristics	Malaysia	Japan	The Netherlands
Climate	Tropical rainforest climate with high annual precipitation.	Seasonal typhoons and high rainfall.	Moderate rainfall, flood-prone from river and sea.
Major Challenges	Urbanisation, improper drainage system, lack of maintenance, flooding or flash floods.	Flooding due to typhoons and rapid urbanisation.	Coastal and riverine flooding and rising of sea level.
Remarkable Flood Mitigation Project	Kuala Lumpur's Stormwater Management Road Tunnel (SMART) and River of Life.	Tokyo Metropolitan Area Outer Underground Discharge Channel (G-Cans project).	Delta Works, Maeslantkering, storm surge barrier.
Stormwater Infrastructure	Integration of BMP and LID techniques such as gross pollutant traps (GPTs), detention ponds, on-site detention, perforated pipe systems, porous pavement, retention ponds, swales, and Integrated Flood and Rainfall Management (IFFRM).	Smart manhole cover, retention pond, swales, green roof, infiltration and Automated Meteorological Data Acquisition System (AMeDAS).	Extensive use of SUDS and BGI practices, water squares, green roofs, swales, permeable pavements, downspout disconnection, underground parking storage and various types of meteorological and hydrological monitoring facilities.
Policies and Regulations	Urban Stormwater Management Manual for Malaysia (MSMA) and National Water Resources Policy.	Urban River Law, Disaster Countermeasures Basic Act, River Law.	Water Act, Delta Programme, "Room for the River" policies.
Responsible Agencies	Department of Irrigation and Drainage (DID), Local Authorities, National Water Services Commission (SPAN) and National Disaster Management Agency (NADMA).	Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Japan Meteorological Agency (JMA).	Ministry of Infrastructure and Water Management, Waterschappen (Water Board), Royal Netherlands Meteorological Institute.
Future Flood Mitigation Projects	Developing green corridor, construction of Sabo Dams and dual-function retention pond.	Expansion of underground detention, utilisation of AI in flood prediction.	Dutch Flood Protection Programme, Delta Programme 2024.

5.0 DISCUSSIONS

The findings above indicate a significant application of techniques or practices in those nations. While Malaysia is known for its tropical rainforest climate with high annual precipitation, Japan experiences seasonal typhoons and high rainfall, and the Netherlands experiences moderate rainfall but is prone to flooding from rivers and the sea. Despite the differences in climatic characteristics, Malaysia could potentially adopt or adapt other stormwater management practices. Observations from the countries reveal that flooding issues are the primary challenges, closely followed by urbanisation.

Based on the case studies, some practices can be adopted. For instance, Malaysian coastal areas, particularly flood-prone areas like Kelantan or Terengganu, may practice storm surge barriers known as Maestlantkering. Forecasts indicate that sea level rise will significantly contribute to flooding in the future; therefore, implementing storm surge barriers could mitigate the negative impacts of these global warming consequences. The storm surge barrier technique will protect the community's property, health, and well-being in these regions.

Furthermore, the SMART Tunnel in Malaysia, which functions as a double-decker motorway and a stormwater tunnel, is an intriguing project that aids flood mitigation (Bobylev, 2007). The SMART Tunnel shares nearly identical concepts with the G-Cans Project in Tokyo, Japan, which is designed to store rainwater during periods of heavy precipitation. However, Japan boasts the largest underground discharge channel capable of withstanding a flood that occurs once every 200 years. Detention ponds, swales, and pervious pavements were used as stormwater infrastructure practices in all three countries. However, due to the relatively new nature of green roofs in Malaysia and the scarcity of commercial materials, Japan and the Netherlands encouraged the implementation of green roofs more than in Malaysia (Ayub, 2020).

According to the Malaysian Meteorological Department (METMalaysia), Malaysia has 43 principal stations and 221 auxiliary stations throughout the country. This shows that our country has a low number of monitoring stations compared to other countries, such as the Netherlands. An increasing number of monitoring stations helps to provide accurate meteorological data and track weather changes. Advanced technology, such as automated systems, is used in weather monitoring to provide highly precise data and an up-to-date system.

For future mitigation projects, Malaysia plans to develop a green corridor, particularly in the city centre of Kuala Lumpur, to enhance the greenery index, reduce the urban heat island, and aid in flood mitigation. In addition, it is highly recommended that Malaysia increases the number of developments at Sabo Dam, adopted from Japan, to reduce flooding due to surface runoff and debris and to create a dual-function retention pond. Meanwhile, Japan is expanding underground detention and utilising artificial intelligence (AI) for flood prediction. The Malaysian government is also interested in using AI in stormwater management.

However, Malaysia must catch up and implement effective stormwater management strategies to mitigate flooding. Sinkholes and flooding continuously hit several areas of the Klang Valley, particularly during heavy rain. This event may be due to a lack of monitoring from the responsible agencies, which sparked curiosity and led to communities becoming more aware of their surroundings. Alternative stormwater mitigation strategies should be considered from various management, planning and development aspects, including government support in the form of tax incentives. With the incentives, developers or building owners may be encouraged to implement stormwater

infrastructure, such as green roofs, downspout disconnection, and rainwater harvesting systems. Raising awareness about flooding problems is crucial, especially regarding inappropriate waste disposal methods, which are one of the factors contributing to flash floods. Therefore, the Malaysian government should tackle this issue rigorously, and countermeasures are necessary to ensure the communities' livelihood, property, and well-being.

6.0 CONCLUSION

This study compares stormwater management practices in developed countries such as Japan and the Netherlands with those in Malaysia. According to the research, both developed countries prioritise stormwater management by implementing new technology and enforcing stricter standards, as seen in the Netherlands, where barriers are built higher than the standards. Malaysia should investigate and implement the most appropriate techniques for the country, considering its unique geographical conditions. The development of expanded underground detention or retention ponds should be considered to address flooding issues, particularly in the Klang Valley area. The focus should be placed on urban areas and implementing storm surge barriers in coastal regions to prevent harmful environmental impacts. The use of AI in current technology also presents great potential for contributing to flood prediction and alleviating flooding issues.

ACKNOWLEDGMENTS

The authors would like to express their gratitude and appreciation to all those who contributed to this study, either directly or indirectly.

REFERENCES

Abdul Khadir, F. K. B., Yee, N. C., Takaijudin, H. B., Zawawi, N. A. W. A., Alaloul, W. S., & Musarat, M. A. (2023). Evaluation of the Implementation of Sustainable Stormwater Management Practices for Landed Residential Areas: A Case Study in Malaysia. *Sustainability (Switzerland)*, *15*(13), 1–20. https://doi.org/10.3390/su151310414

Acierto, R. A., Kawasaki, A., Zin, W. W., Oo, A. T., Ra, K., & Komori, D. (2018). Development of a hydrological telemetry system in Bago river. *Journal of Disaster Research*, *13*(1), 116–124. https://doi.org/10.20965/jdr.2018.p0116

Assaf, G., & Assaad, R. H. (2023). Optimal Preventive Maintenance, Repair, and Replacement Program for Catch Basins to Reduce Urban Flooding: Integrating Agent-Based Modeling and Monte Carlo Simulation. *Sustainability (Switzerland)*, *15*(11). https://doi.org/10.3390/su15118527

Ayub, K. R. (2020). Green Roof Performance for Stormwater Management in Malaysia. *Research Gate*, *21*(1), 1–9.

Azhar, S., Chen, Y., Feng, A., Sun, S., Trevino, L., & Vu, T. (2021). *Infrastructure Asset Management for Developing Countries to Achieve the SDGs Case Studies*.

Bibi, T. S., Reddythta, D., & Kebebew, A. S. (2023). Assessment of the drainage systems performance in response to future scenarios and flood mitigation measures using stormwater management model. *City and Environment Interactions*, *19*(June), 100111. https://doi.org/10.1016/j.cacint.2023.100111

Birch, H., Bergman, M., Backhaus, A., Fryd, O., & Ingvertsen, S. T. (2008). *Sustainable Urban Drainage Systems - 8 case studies from the Netherlands*. *May*, 53.

Bobylev, N. (2007). Sustainability And Vulnerability Analysis Of Critical Underground Infrastructure. *Managing Critical Infrastructure Risks*, pp. 445–469. https://doi.org/10.1007/978-1-4020-6385-5_26

Boogaard, F. C. (2023). *Stormwater quality management and Climate Adaptation in the Netherlands (Regenwassermanagement und Klimafolgenanpassung in den Niederlanden)*. *December*.

Boogaard, F., Van de Ven, F., Langeveld, J., & Van de Giesen, N. (2014). Stormwater Quality Characteristics in (Dutch) Urban Areas and Performance of Settlement Basins. *Challenges*, *5*(1), 112–122. https://doi.org/10.3390/challe5010112

Brouwer, R., & Van Ek, R. (2004). Integrated ecological, economic and social impact assessment of alternative flood control policies in the Netherlands. *Ecological Economics*, *50*(1–2), 1–21. https://doi.org/10.1016/j.ecolecon.2004.01.020

Chang, N. Bin, Lu, J. W., Chui, T. F. M., & Hartshorn, N. (2018). Global policy analysis of low impact development for stormwater management in urban regions. *Land Use Policy*, *70*(June 2016), 368–383. https://doi.org/10.1016/j.landusepol.2017.11.024

Diakomopoulos, F., Antonini, A., Bakker, A. M. R., Stancanelli, L. M., Hrachowitz, M., & Ragno, E. (2024). Probabilistic characterisations of flood hazards in deltas: Application to Hoek van Holland (Netherlands). *Coastal Engineering*, *194*(August). https://doi.org/10.1016/j.coastaleng.2024.104603

DID. (2008). *SUBMISSION CHECKLIST FOR STORMWATER MANAGEMENT IN MALAYSIA*.

DID. (2012). *Urban Stormwater Management Manual for Malaysia*.

Diya, S. G., Kamarudin, M. K. A., Gasim, M. B., Toriman, M. E., Juahir, H., Umar, R., Saudi, A. S. M., Abdullahi, M. G., & Rabiu, A. A. (2018). Flood simulation model using XP-SWMM along Terengganu River, Malaysia. *Journal of Fundamental and Applied Sciences*, *9*(2S), 66. https://doi.org/10.4314/jfas.v9i2s.5

Fang, C., Liu, H., & Wang, S. (2021). The coupling curve between urbanisation and the eco-environment: China's urban agglomeration as a case study. *Ecological Indicators*, *130*(July), 108107. https://doi.org/10.1016/j.ecolind.2021.108107

Fletcher, T. D., Shuster, W., Hunt, W. F., Ashley, R., Butler, D., Arthur, S., Trowsdale, S., Barraud, S., Semadeni-Davies, A., Bertrand-Krajewski, J. L., Mikkelsen, P. S., Rivard, G., Uhl, M., Dagenais, D., & Viklander, M. (2015). SUDS, LID, BMPs, WSUD and more – The evolution and application of terminology surrounding urban drainage. *Urban Water Journal*, *12*(7), 525–542. https://doi.org/10.1080/1573062X.2014.916314

Francesch-Huidobro, M., Dabrowski, M., Tai, Y., Chan, F., & Stead, D. (2017). Governance challenges of flood-prone delta cities: Integrating flood risk management and climate change in spatial planning. *Progress in Planning*, *114*, 1–27. https://doi.org/10.1016/j.progress.2015.11.001

Grandgirard, J., Poinsot, D., Krespi, L., Nénon, J. P., & Cortesero, A. M. (2002). Costs of secondary parasitism in the facultative hyperparasitoid Pachycrepoideus dubious: Does host size matter? *Entomologia Experimentalis et Applicata*, *103*(3), 239–248. https://doi.org/10.1023/A

Hasan, H. H., Razali, S. F. M., Zaki, A. Z. I. A., & Hamzah, F. M. (2019). Integrated hydrological-hydraulic model for flood simulation in tropical urban catchment. *Sustainability (Switzerland)*, *11*(23), 1–24. https://doi.org/10.3390/su11236700

Jones, A., Kuehnert, J., Fraccaro, P., Meuriot, O., Ishikawa, T., Edwards, B., Stoyanov, N., Remy, S. L., Weldemariam, K., & Assefa, S. (2023). AI for climate impacts: applications in flood risk. *Npj Climate and Atmospheric Science*, *6*(1). https://doi.org/10.1038/s41612-023-00388-1

Kuala Lumpur City Hall– City Planning Department. (2024). Kuala Lumpur Structure Plan 2040. *Https://Ppkl.Dbkl.Gov.My/En/Ppkl2040/*.

Kubota, T., Hashizume, H., Shige, S., Okamoto, K., Aonashi, K., Takahashi, N., Ushio, T., & Kachi, M. (2006). Global precipitation map using satellite-borne microwave radiometers by the GSMaP project: Production and validation. *International Geoscience and Remote Sensing Symposium (IGARSS)*, *45*(7), 2584–2587. https://doi.org/10.1109/IGARSS.2006.668

Kumar, N., Liu, X., Narayanasamydamodaran, S., & Pandey, K. K. (2021). A systematic review comparing urban flood management practices in India to China's sponge city program. *Sustainability (Switzerland)*, *13*(11). https://doi.org/10.3390/su13116346

Kummerow, C., Barnes, W., Kozu, T., Shiue, J., & Simpson, J. (1998). The Tropical Rainfall Measuring Mission (TRMM) sensor package. *Journal of Atmospheric and Oceanic Technology*, *15*(3), 809–817. https://doi.org/10.1175/1520-0426(1998)015<0809:TTRMMT>2.0.CO;2

Malik, N. K. A., Manaf, L. A., Jamil, N. R., Rosli, M. H., Yusof, F. M., & Ash'aari, Z. H. (2019). The quantification of urban litter load at gross pollutant trap along Sungai Batu, Selangor. *Planning Malaysia*, *17*(2), 27–37. https://doi.org/10.21837/pmjournal.v17.i10.626

Misni, A., & Shahfuddin, N. A. F. A. (2017). Low-impact development: Minimising stormwater runoff in a case study of section 13, Shah Alam, Malaysia. *WIT Transactions on Ecology and the Environment*, *220*, 205–215. https://doi.org/10.2495/WRM170201

Mohamad Yusoff, I., Ramli, A., Mhd Alkasirah, N. A., & Mohd Nasir, N. (2018). Exploring the managing of flood disaster: A Malaysian perspective. *Malaysian Journal of Society and Space*, *14*(3), 24–36. https://doi.org/10.17576/geo-2018-1403-03

Mosselman, E. (2022). The Dutch Rhine branches in the Anthropocene – Importance of events and seizing of opportunities. *Geomorphology*, *410*(April), 108289. https://doi.org/10.1016/j.geomorph.2022.108289

Muhd Zain, N., Elias, L. S., Paidi, Z., & Othman, M. (2020). Flood Warning and Monitoring System (FWMS) using

GSM Technology. *Journal of Computing Research and Innovation*, *5*(1), 7–18. https://doi.org/10.24191/jcrinn.v5i1.158

O'Donnell, E. C., Netusil, N. R., Chan, F. K. S., Dolman, N. J., & Gosling, S. N. (2021). International perceptions of urban blue-green infrastructure: A comparison across four cities. *Water (Switzerland)*, *13*(4), 1–25. https://doi.org/10.3390/w13040544

Pickvance, C. (2005). The four varieties of comparative analysis: the case of environmental regulation. *Paper for Small and Large-N Comparative Solutions Conference, University of Sussex*, *September* 22–23.

Ramly, S., Tahir, W., Abdullah, J., Jani, J., Ramli, S., & Asmat, A. (2020). Flood Estimation for SMART Control Operation Using Integrated Radar Rainfall Input with the HEC-HMS Model. *Water Resources Management*, *34*(10), 3113–3127. https://doi.org/10.1007/s11269-020-02595-4

Saleh Dutsenwai, H., Bin Ahmad, B., Mijinyawa, A., & B. Wan Yusof, K. (2015). Fusion of SAR Images for Improved Classification of Flooded Areas in Northern Peninsular Malaysia. *Research Journal of Applied Sciences, Engineering and Technology*, *11*(3), 259–266. https://doi.org/10.19026/rjaset.11.1715

Saraswat, C., Kumar, P., & Mishra, B. K. (2016). Assessment of stormwater runoff management practices and governance under climate change and urbanisation: An analysis of Bangkok, Hanoi and Tokyo. *Environmental Science and Policy*, pp. *64*, 101–117. https://doi.org/10.1016/j.envsci.2016.06.018

Shibuo, Y., & Furumai, H. (2021). Advances in urban stormwater management in Japan: A review. *Journal of Disaster Research*, *16*(3), 310–320. https://doi.org/10.20965/jdr.2021.p0310

Sidek, I. D. L. M., Ghani, A. A., Zakaria, N. A., Desa, M. N., & Othman, N. (2006). An Assessment of Stormwater Management Practices in Malaysia. *International Conference on River Management in the 21st Century: Issues and Challenges RIVERS'04, 21 - 23 September 2004, Penang*, *January*.

Song, C. (2022). Application of nature-based measures in China's sponge city initiative: Current trends and perspectives. *Nature-Based Solutions*, *2*(October 2021), 100010. https://doi.org/10.1016/j.nbsj.2022.100010

Starzec, M., Dziopak, J., & Słyś, D. (2020). An analysis of stormwater management variants in urban catchments. *Resources*, *9*(2). https://doi.org/10.3390/resources9020019

Tang, K. H. D. (2019). Climate change in Malaysia: Trends, contributors, impacts, mitigation and adaptations. *Science of the Total Environment*, *650*, 1858–1871. https://doi.org/10.1016/j.scitotenv.2018.09.316

Tromp, E., Te Nijenhuis, A., & Knoeff, H. (2022). The Dutch Flood Protection Programme: Taking Innovations to the Next Level. *Water (Switzerland)*, *14*(9). https://doi.org/10.3390/w14091460

Uchiyama, S., Bhattacharya, Y., & Nakamura, H. (2023). *Implementing Green Infrastructure for Urban Stormwater Management: A Systematic Review to Identify Future Challenges for Japan*. *January*. https://doi.org/10.2139/ssrn.4358478

UNESCO. (2021). *AI to improve Japan's disaster readiness and response*. 2019.

Verweij, S., Busscher, T., & van den Brink, M. (2021). Effective policy instrument mixes for implementing integrated flood risk management: An analysis of the 'Room for the River' program. *Environmental Science and Policy*, *116*(December 2020), 204–212. https://doi.org/10.1016/j.envsci.2020.12.003

Wan Abdul Majid, W. H. A., Brown, E., Osman, S., Asan, G., Osman, A. Q., Samsudin, R. K., Boelee, L., & Ahmad, F. (2017). *Flood forecasting and warning for river basins in Malaysia: non-structural measures for flood mitigation*. *7710*(1).

Wu, J., Cheng, D., Xu, Y., Huang, Q., & Feng, Z. (2021). Spatial-temporal change of ecosystem health across China: Urbanisation impact perspective. *Journal of Cleaner Production*, *326*, 129393. https://doi.org/10.1016/J.JCLEPRO.2021.129393

Xiong, Y. (2021). *Stormwater Adaptive Resilience and the Assessment of Rotterdam's Urban Water System*.

Yang, Y., Li, J., Huang, Q., Xia, J., Li, J., Liu, D., & Tan, Q. (2021). Performance assessment of sponge city infrastructure on stormwater outflows using isochrone and SWMM models. *Journal of Hydrology*, *597*(October 2020), 126151. https://doi.org/10.1016/j.jhydrol.2021.126151

Yeo, O. T. S., Yusof, M. J. M., Maruthaveeran, S., Saito, K., & Kasim, J. A. (2023). A Review of Green Infrastructure Establishment Policies and Regulations in Kuala Lumpur, Malaysia. *Pertanika Journal of Social Sciences and Humanities*, *31*(2), 561–584. https://doi.org/10.47836/pjssh.31.2.06

Zakari, N. A. (2016). *MSMA 2nd Edition – Application of Green Infrastructures for Solving Sustainable Urban Stormwater Management Challenges*. 1–10.

Zhang, J., Fu, D., & Zevenbergen, C. (2022). Moving Towards Water Sensitive Cities: A Planning Framework, Underlying Principles, and Technologies—Case Study Kunshan Sponge City. In *Encyclopedia of Inland Waters, Second Edition* (2nd ed., Vol. 4). Elsevier Inc. https://doi.org/10.1016/B978-0-12-819166-8.00185-7

JOURNAL OF ARCHITECTURE, PLANNING & CONSTRUCTION MANAGEMENT
Volume 14 Issue 2, 2024 E-ISSN: 2462-2222 ISSN: 2231-9514

UTILISATION OF OPEN SPACES IN ENHANCING ARCHITECTURAL SUSTAINABILITY: A CASE STUDY OF METROPOLITAN LAGOS

Received: 16 December 2023 | Accepted: 20 August 2024 | Available Online: 7 December 2024
DOI: 10.31436/japcm.v14i2.839

Segun Okunola [1*], Bola Ogunbodede [2], Akinfolarin Jobi [3]

[1] Department of Architecture, University of Lagos, ookunola@unilag.edu.ng*
[2]Department of Architecture, University of Lagos, bogunbodede@unilag.edu.ng
[3]Department of Architecture, University of Lagos, ajobi@unilag.edu.ng

Corresponding author: **Segun Okunola*
Corresponding author's email: ookunola@unilag.edu.ng

ABSTRACT

As a result of urbanisation, green fields in urban Lagos are being lost to urban development, with more open spaces being encroached. Tafawa Balewa Square's bordering racecourse has recently been misused and is now being landscaped as a concrete jungle. The poor quality of ancient open spaces in Lagos state is aptly demonstrated by the degradation of Lagos Marina by overhead bridges and the coastal erosion that erased the Lagos Bar Beach on Victoria Island to coastal erosion. To improve architectural sustainability: a case study focuses on Metropolitan Lagos. The qualitative analysis method compares the study area's built-up area to the land area initially designated for open space in the original plan. This study found that residents' social, economic, and cultural activities interact in complicated ways in open spaces, which serves as justification for using the location or nearby building.

Keywords: Green Space, Housing Estate, Open Space, Sustainability, Urbanization

1.0 INTRODUCTION

In metropolitan centres, the presence of open space is crucial. Prior to urbanisation, it is crucial to conserve the current green area. Urban open spaces serve as a repertoire of unique attractiveness and a marker for people's culture and history. (David & Senem, 2017). Open spaces help to foster an urban environment that enhances livability and protects and restores ecological diversity through the pathways of recreation for urban residents and sanctuary for endangered plants and animals. It also aids in reducing the impact of natural disasters. (Jegede, Adewale, & Olaniyan, 2019). Open spaces set a template for urban aspirations and recommend patterns for realisation. Researchers suggest that the inadequacy of open spaces and those available are misused and mismanaged, leading to a physical template on the environment and welfare of residents, which is symptomatic of its poor quality. (Olanusi, Akingbohungbe, & Ogunruku, 2017).

Therefore, the aspiration to attain a healthy and sustainable environment will require identifying and analysing urban open spaces related to city planning. According to Akintoye and Opeyemi (2014), there are numerous qualitative and quantitative issues with urban open space today. The required amount of open spaces is confined on a widespread basis. The housing market is congested, particularly in high-density areas where people are confined to buildings without access to outside spaces for recreation and gardening, which results in the street becoming a playground (Cooke, 2017). Viewing open space as less critical than other land uses would be inappropriate. Open space always loses when competing claims for a

specific piece of land are made by dwelling, parking, commercial, industrial, and other land use categories. This issue has made the investigation necessary (Kingsley & Omatsone, 2010).

Lagos state often experiences seasonal flooding during the rainy season because it is one of those states with a very high-water table and is also subjected to industrial effluent discharge into lagoons and waterways, which are also compounded by the indiscriminate dumping of refuse in open spaces. (Emordi, 2005). Lagos State is launching a greening project to maintain and conserve the biodiversity and ecology of the environment in Lagos state in order to accomplish the 7th Millennium Development Goal, which is to ensure environmental sustainability. (Kingsley & Omatsone, 2010). Certain government policy workers have realised that preserving open spaces can enhance recreation,

instigate natural disasters, and preserve specific geographical and biological attributes, which can incentivise preservation efforts (Leah, 2000). The observable trend of urban growth is low density along the urban fringe, which may come with the loss of open space creation and reduction of existing one (Kitchin & McArdle, 2015).

This study emphasised the current shortage of open spaces in the state to give an acceptable sociocultural response to the citizens' need for recreational options in Manifestation of Defensible Space in Lagos State Development and Property Cooperation Housing Estates, Lagos, Nigeria (Jegede *et al*., 2018). The study focuses on the present situation and the utilisation of open spaces to comprehend their problems by comparing the government housing estate in Lagos State. The focal point of this study is the governing agency, if there is one. In this study, the physical and aesthetically pleasing characteristics of urban spaces are covered, and the provision, availability, sufficiency, and use of open spaces within the Lagos metropolitan area are emphasised. (David & Senem, 2017).

2.0 LITERATURE REVIEW

Typically, public places provide opportunities for leisure, cultural, and enjoyment activities. Cities' social and economic activities revolve around them and should be seen as crucial land use, equally crucial to other land uses. (Bashorun & Ayeni, 2013). The concept of recreation spaces suited for recreation, both active and passive, goes beyond vacant lots, parks, and neighbourhood squares. Open spaces encompass conservation land (government-owned or organisational) earmarked for agricultural lands, green buffers to roads, and spaces for recreation, either passive, such as walking or hiking, or active, such as soccer, tennis, or basketball (Michael, 2009). Cities of the global south are witnessing unprecedented population increases in urban centres, particularly since the last century, which has resulted in explosive urban growth that has culminated in megacities. In the emerging world, two factors accelerate urban population increase: natural growth occasioned by a net increase in birth rate and rural-urban migration brought about by the supposed city appeal as the centre of prosperity. (Angelidou & Psaltoglou, 2017).

Any city's land use can be split into two main categories as a function of its landscape. The first category consists of the structures that house the various functions, such as business, housing, industry, and education. The second group comprises the nearby parks, residential yards, public and private roadways, and undeveloped land (Ndidi & Anthony, 2008). The people in which the city is built are more significant than the natural and climatic conditions that affect the cityscape. Open space is territory left in its natural state or transformed into artificial gardens for use or enjoyment in a parallel universe (Oduwaye, 2005). This change can also be considered conserved terrain with a particular aspect, such as preserved panoramic or historical significance. Open spaces come in different types and complexities, from front gardens to private backyards, and

others are complex, like school playgrounds, race courses, golf courses, botanical gardens, and country regional parks. This concept could also be broadly used in waterways, rivers, valleys, hills, mountains, lakes, and oceans (Bashorun & Ayeni, 2013).

Significantly, open space provides benefits ranging from scientific to air and water pollution mitigation, reducing urban sprawl to the social level, like crime reduction, revitalising neighbourhoods to make them more home cohesive, and providing recreation opportunities. Economic benefits through business opportunities and attractive property values are also there (Dimuna, 2011). It is a tremendous disappointment that open spaces are disappearing in some areas of Lagos, which has numerous adverse effects on the quality of life and property values. The upper and middle classes will not frequently be present in a neighbourhood lacking recreational amenities. The building of homes also displays the development of slum and ghetto conditions without enough ventilation (Aluko, 2011).

Open spaces and gardens play a crucial role in the structure and use of urban centres. Residents' utilisation of open spaces takes many various forms. Open spaces are an essential component of the urban landscape, shape its function, and have the quality of life as one of its outcomes (Olanusi *et al*., 2017). Furthermore, Open spaces mirror a city's social and psychological fabric and provide a window through which its cultural diversity is displayed while also serving as a repository of memories for the city dwellers. Open spaces are generally seen as land in its natural form, either existing in its natural form or altered to form gardens (Michael, 2009).

2.1 Importance of Open Spaces

Additionally, the presence of open spaces offers several opportunities. First is the opportunity for social inclusion through social interaction. This opportunity can encourage communal activity and capacity building that fosters citizenship and local pride, which may reduce antisocial behaviour and crime (Kitchin & McArdle, 2015).

Open spaces are also the go-to places for cultural activities in urban centres, serving as channels for preserving the city's cultural heritage

by helping to mould a visually pleasant environment that can support living, working, and exploration. It helps stabilise local housing and markets, attracting investments that boost economic activities. The benefits of open spaces also extend to children and young adults, as physical activity and fresh air can help them stay healthy and safe from illnesses like obesity (Basiri *et al*., 2017). Open spaces also benefit urban cities in the pursuit of a sustainable environment by helping to reduce population and offering ecological and visual diversity, something that used to be the preserve of the countryside (Cooke, 2017).

2.2 Urbanisation

Expansion in the urban cities often outstrips those of the countryside; as regards population growth, especially in third world countries, this growth now strains on city amenities like water, electricity, and public transport, leading to what can be referred to as an inverse relationship between population growth and quality of life (Ellis & Roberts, 2016). This growth manifests as sociological problems of crime, health, inadequacies, low education, and other incidental environmental issues. However, the reality of urbanisation is often that of desperate ecological centres that have experienced decapitation to giveaway to the more economically rewarding high-rise apartment buildings (Adejumo, 2002).

This distortion results in open spaces that are not amenable to correction. However, elements of open spaces like parks, beaches, and nature reserves located in urban areas generate quality urban living. (Bashorun & Ayeni, 2013). In the same vein, gardens are a form of open space that serves as a venue for social gatherings, sports, and educational meetings and helps to reinforce diversity and place identity for urban residents. (David & Senem, 2017).

2.3 Green Space Concept

These gardens conveniently support human activity while sustaining wildlife, plants, and aquatic conditions. This balance ensures an adequate quality of life for urban dwellers. The above assertion is also valid for green space regarding quality of life; it is better appreciated when viewed as flora and fauna. These pillars of biodiversity make a city worth living (Adejumo, 2002).

2.4 The British Open Space

Historically, as far back as the nineteenth century, the countryside has receded in proportion to the growth of its cities; this leads to the deprivation of residents of places for healthy exercise and recreation. It also manifests as school playgrounds, which provide places for schoolchildren

to train and play, and teachers organise various sports like football. This activity will eventually develop into school sports and games associations (Angelidou & Psaltoglou, 2017). Several rules apply to how open spaces are laid out and planned in all New Towns in Britain, following the excellent London development plan (Ellis & Roberts, 2016).

The following recommendations are focused on: offering fields, with a suggested standard of 6 acres per 1,000 people; offering pitches, courts, and green belt areas for public or private usage; offering play areas for kids, such as traditional playgrounds (with permanent equipment and hard surfaces), standard designs, and areas for ballgames (with goal posts and floodlights) (Ellis & Roberts, 2016). Depending on the availability of space, there are natural play areas (land left in its natural state with hollows and bushes), toddler areas, adventure playgrounds, and comprehensive playgrounds. A path and a golf course are also available, depending on the age distribution, growth in demand brought on by the leadership, youth services, local conditions, participation patterns, climate, and the proximity of available space. Broad space guidelines have been formulated by the Greater London Council (GLC) for Town growth proposals (Ellis & Roberts, 2016).

Table 1: Greater London Council's suggested open space standard

OPEN SPACE	TYPE	AREA/ACRE (Ac)	POPULATION
Town	Park	1 Ac	1,000
Public	Playfield	215-3 Ac	1,000
Private	Playfield	1 Ac	1,000
Children	Playspace	0.5 Ac	1,000
Remaining	Playspace	7-8 Ac	1,000
Total		12-13.5 Ac	5,000

Source: Greater London Council Field Survey

Other organisations create other population range guidelines that consider sports and social development in addition to this regulation, which governs how open space is developed in Great Britain. Furthermore, because Ebenezer Howard, a famous utopian and the creator of

the Garden City idea, was the brains behind these parks in the nineteenth century, the British experience emphasises the availability of parks. It is difficult to imagine any district or location in Great Britain needing more parks due to the country's importance of parks (Cooke, 2017).

2.5 Nigeria Open Space

It is nearly incomprehensible that modern Nigerian cities (Lagos, Kano, Ibadan, and Benin) have prioritised the supply of open space less than older ones because early settlements in Nigeria have always incorporated open spaces and gardens. Provision for town gardens, walks, lanes, and roadways is a subject of development alternatives, such as in Ile-Ife, Igbo, and Hausa towns. (Akintoye & Opeyemi, 2014). Unfortunately, Contemporary city developments have systematically taken over existing open spaces and have gone ahead to eliminate them together in new and expanding schemes. Typically, courtyard houses or "courtyard architecture" enclose the open areas to provide outdoor space within residential areas, witnessing the progressive disappearance of courtyard architecture. Urban dwellers' activities have increasingly been squeezed to the point of discomfort. Shaded open spaces that serve as outlets for heat generated by buildings and that also serve noise, dust, and odour filters, thereby encouraging relaxation, are disappearing. (Olanusi *et al*, 2017).

2.6 Lagos State Open Space

Relaxation and the need for open areas to appreciate one's interests have historically been neglected in Lagos. As a result, there are now few amenities in urban areas that promote or even permit the general population to exercise, play, or unwind away from the hustle and bustle of urban life. (Emordi, 2005). Open spaces and their amenities seem novel or unimportant to policymakers. To address the population's requirements, the Lagos State Government, for example, needs to provide urban places for recreation through its facilities; the most current ones need to be adequate for the population. They need to be more readily available. It can be argued with accuracy that the numerous concepts proposed in the past state government approach to open space management and protection have yet to produce any tangible results (Adejumo, 2002).

2.7 Standard for Open Space in Lagos State Residential Housing

This "New Town" idea is considered a valuable addition to already existing towns and cities because it helps Lagos. This city is rapidly expanding, absorbing, and dispersing its extra inhabitants. (David & Senem, 2017). The allotment of open spaces in Lagos New Town is based on the specific standards and parameters listed in Table 2. In low-density estates, 5% is frequently budgeted for open space, while 10% of the total land area for high-density housing projects is kept as designated open spaces. The overall population of New Town is in proportion to the total area of land that is developed. In essence, the design criterion must include a determination of the population density per unit area. The goal of any design is to maintain the density of people per unit area as low as feasible. Making such a choice avoids slum conditions and urban congestion. (Oduwaye, 2005).

Table 2: Recommendations for open space in Lagos State housing developments

Usage	Total areas of public open space
High density	5–10% of the total open area
Medium	3 – 7% of the total open area
Low density	2 -5% of the total open area

Sources: Lagos State Development Planning Unit

Table 3: Proportional Land Use in Lagos State's New Town Projects

Usage	Percentage for use
Residential	A range of 60 and 70%
Commercial	A range of 15 and 32%
Roads	A range of 15 and 20%
Industrial	As required
Recreation	A range of 10 and 20%

Sources: New Town Development Authorities

2.8 Study Area

The study region is the Lagos Metropolitan region, located between latitude 60° 22'N and longitudes 20° 42'E and 30° 22'E East, respectively. The oblong shape lies along the coast of the Atlantic, covering a distance of about 180 kilometres, and is bordered to the east and south by the Nigerian state of Ogun and the Republic of Benin, respectively (Aluko, 2011). Its five administrative divisions are Ikeja, Badagry, Ikorodu, Lagos Island, and Epe. It covers an area of approximately 358,862 hectares or 3,577 sq. km and comprises five (5) administrative divisions: Ikeja, Badagry, Ikorodu, Lagos Island, and Epe. The Ogun Rivers, Ologe Lagoon, Kuramo Waters, Badagry Beach, Five Cowries, and Omu Creeks are only a few of the state's natural water features (Esan, 2021).

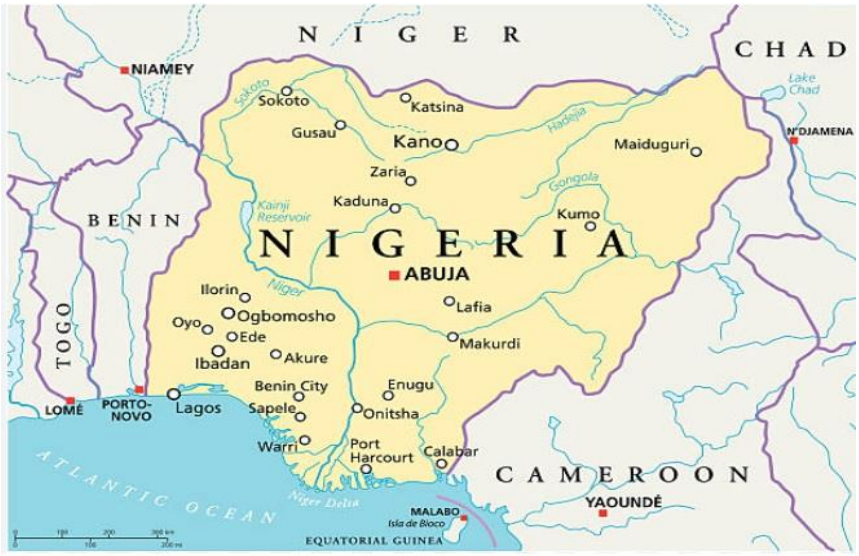

Fig. 1: Lagos State within Nigeria context

Source: Google map. https://images.app.goo.gl/Woy3K3q2E47VJZh68

Since the 16th century, there have been numerous alterations. The creation of banks and telephone services was a crucial component in the development of Lagos and its surroundings. The first railway connecting Lagos and Otta was built in 1897, and 95 kilometres of the lines were finished. (Johnson, 2010). There have been attempts to build a bridge between the Island and the Mainland, rehabilitate some Oko-Awo areas, or relocate residents to Surulere, Yaba, or Ebute-Metta. The Lagos Chamber of Commerce was established in 1877, and the General Post Office in 1808. Lagos state saw a tremendous rate of expansion between 1809 and 1968. The area's land mass expanded from 1.55 square miles in 1891 to 27.22 square miles in 1963. (Adejumo, 2002).

3.0 METHODOLOGY

In order to compare the extent of the actual built space in the study area to the land area allotted for open space in the original plan, a qualitative analysis method is used, as the degree to which open space in the state complies with the law, the function of Lagos State planning standards and the experts in the built environment. The survey targeted notable residential estates in Lagos State, while 30 in-depth interviews and 6 focus group sessions were conducted with professionals in the built environment and community leaders. Additionally, open spaces were selected for detailed analysis. Interviews and focus groups were held for residents of public residential estates owned by the Lagos State Development Property Corporation and the New Town Development Authority (NTDA) in the Omole Scheme Estate, Iba Housing Estate, and Raji Rasaki Estate. This study entails the Lagos State Housing Company deciding on the style of residential homes. Responses include government employees, independent contractors, non-government employees, and professionals in the built environment.

4.0 RESULTS AND DISCUSSION

The following was discussed regarding the open spaces that are currently present, as well as the physical, social, and historical context of the chosen residential estates in Lagos State, including Lekki Peninsula Scheme 1, Dolphin Estate Ikoyi, M.K.O. Abiola Garden City, Omole Scheme Ikeja, Iba Housing Estate, Raji Rasaki Estate, Alliance Housing Scheme, and Alliance Housing Scheme, Ojokoro.

Among these estates, Lekki Peninsula Scheme 1, established in 1982, spans 1,046.60 hectares and caters to the affluent yet needs help in the planning authority's implementation, leading to the reallocation of designated recreational space for residential purposes. Dolphin Estate, completed in 1991, is a low-density residential neighbourhood lacking adequate amenities for outdoor leisure, and its open space faces limitations due to a reservoir tank and other uses. MKO Abiola Garden, initially known as Marwa Garden, was implemented under the Lagos State Family Support Programme in Ikeja Local Government and contributed to the region's social and recreational landscape. Omole Scheme 1, within Ikeja Local Government, includes an open area that is poorly maintained but utilised by local children for football. Iba Housing Estate, located southwest of Ojo town, represents a newly developed neighbourhood with distinct areas like the ancient Iba town and the Iba Housing Estate constructed under the Jakande Administration, reflecting the diverse residential fabric in Lagos State.

4.1 Availability of Open Space

The findings on the amount of open space in the residential areas under study showed the relevance of open space and the need to access its availability. Conclusions drawn from the findings are as follows: Lekki Peninsula recorded 28% of open space that was available and 72% of estates that were unavailable; 36% of the area at Dolphin Estate was open space, while 64% was unusable quite the opposite; The MKO Abiola Garden calculated a 39% availability rate for open space and a 61% non-availability rate; Omole scheme showed 32% of open area to be available and 68% to be unavailable; Iba Estate scored 51% for open space that was available and 49% for the area that was not; Raji Rasaki recorded 19% for open space that was available and 81% for unavailability.

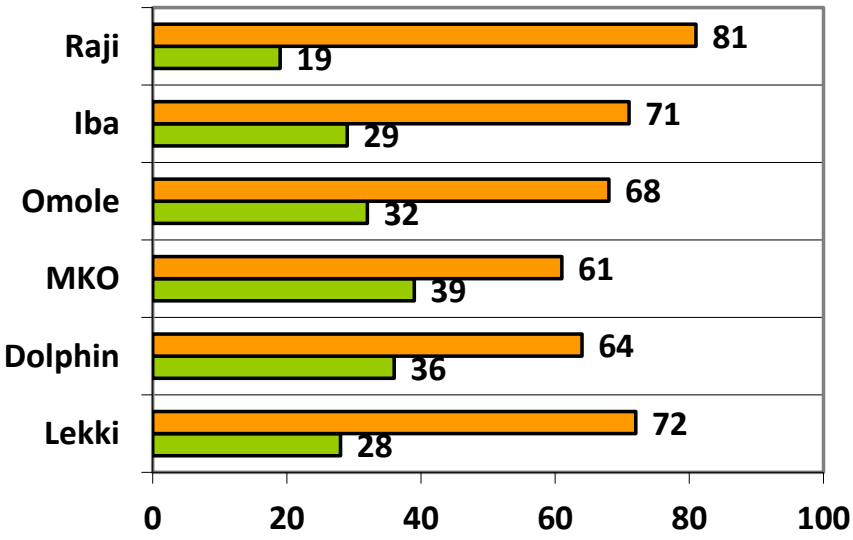

Fig. 2: Availability of open space

4.2 Comparison of Open Space with Stipulated Standards

According to the report, the Lekki Peninsula has 1.01% of its area for recreational use. Compared to the government-provided standard for open space, Dolphin Estate has 1.42%, MKO has 2.31%, Omole Scheme has 3.63%, Iba has 2.48%, and Raji Rasaki has 1.4%. These results show ineffectiveness and a need for more management control of open spaces by the appropriate channel to supervise and lead land use development for the state's residential estates, especially the planning authority.

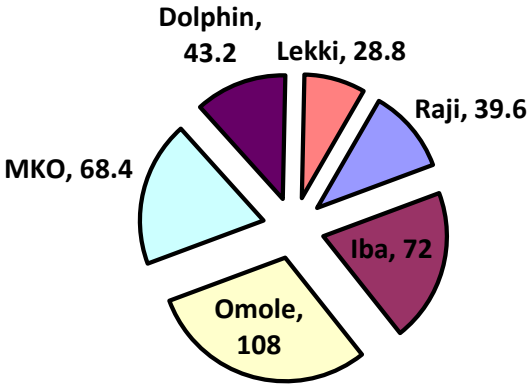

Fig. 3: Comparison of open space with stipulated standard

4.3 Existing Use of the Open Space

The need for proper use of these open spaces within residential areas makes it necessary to ascertain how the open space in residential estates is currently being used. On the Lekki Peninsula, there were 21% recreational gardens, 9% open areas, 22% playgrounds, and 48% other uses, such as celebrations, religious activities, and ceremonies. A recreational garden, a children's playground, open space, and other uses comprised 27%, 30%, 40%, and 12% of Dolphin Estate. MKO Abiola noted 59% for a garden for recreation, 30% for a playground for

kids, and 11% for other uses. Omole Scheme 1, on the other hand, recorded 46% for a recreational garden, 22% for a playground for kids, 14% for open land, and 18% for other purposes. Iba Estate had a recreational garden, a playground, and 25% open space, with the remaining 19% used for other purposes.

Raji Rasaki also noted 19% for leisure activities, 21% for playgrounds, 22% for open space, and 38% for other uses.

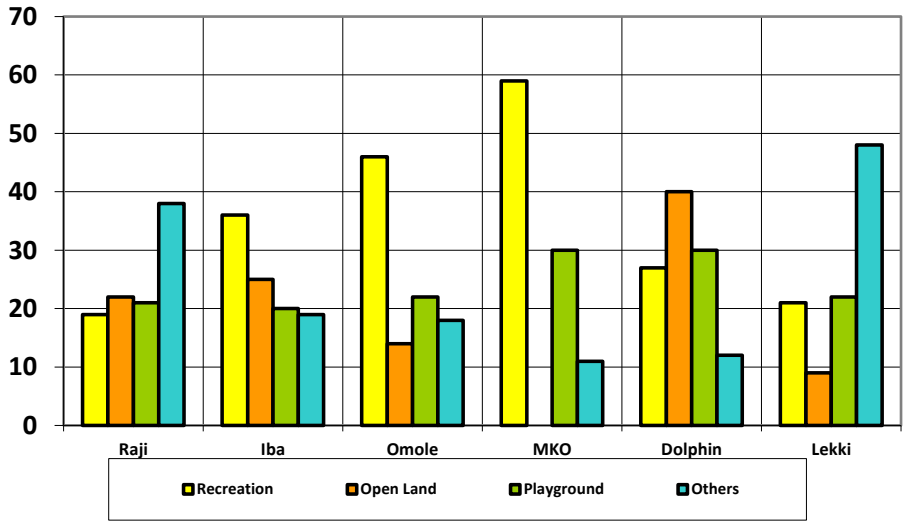

Fig. 4: Existing use of the open space

4.4 Maintenance of Open Space

The level of upkeep of the open spaces in the housing estates was as follows: Only 17% of the open space, according to Lekki Peninsula, was kept in good shape, while 83% of the remaining land was not. In Dolphin Estate, just 26% of the open space was effectively maintained, while the other 74% required additional care from the appropriate parties. According to MKO Abiola, only 28% of public places are kept up to code, while 72% are ignored. Omole Scheme 1 scored 31% for adequately maintained and 69% for inadequately maintained. Iba Estate has a rating of 85% poorly kept and 15% appropriately maintained. Raji Rasaki has 9% of its open space that was effectively maintained, and 91% of it needs to be better maintained.

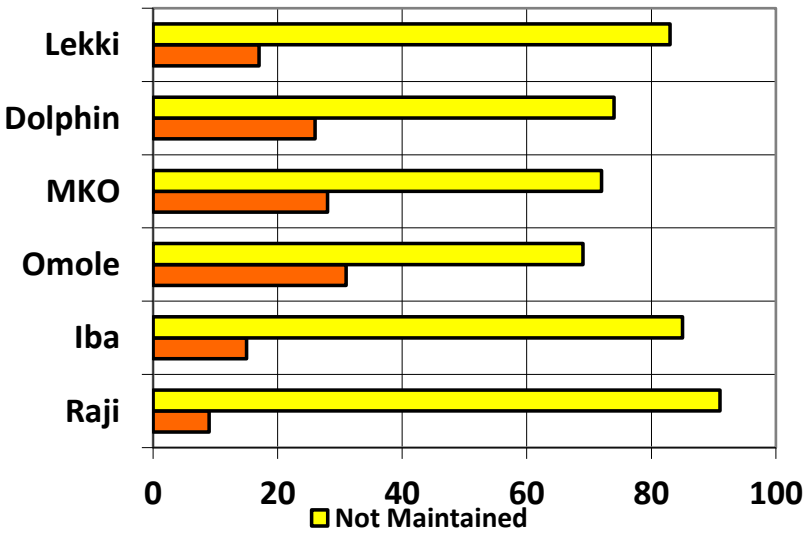

Fig. 5: Maintenance level of open space

5.0 CONCLUSION

An open space is a tangled web of neighbourhood economic and sociocultural activity that justifies using the location or nearby building. Social and cultural activities in a public area are pertinent to structuring a community. The site's social, economic, and cultural infrastructure and the services offered to citizens are significant factors to consider. The public has very high standards for social comfort and open space. As stated in this study, there were numerous problems with open spaces in residential areas, including poor application of open space standards by architects, failure of the planning authority's framework for developing and managing open space, architects, and non-development of land reservations. Consequently, statutory authorities needed a precisely defined function in maintaining open space.

To ensure a quality environment, it is advised that the government set up a plan to design, build, administer, and promote beautiful open spaces in the city of Lagos. Policymakers should prioritise open space and chances for survival. In order to direct the design, development, and administration of open space in residential estates, it is also necessary to adopt planning criteria. The private and governmental sectors work together to launch a campaign for landscape enhancement and open space management within residential complexes. Resources must be pooled to raise the money needed to build infrastructure for outdoor recreational activities and promote the beauty of open space. A window should be opened to address the lack of park gardens and effectively manage open space in housing estates.

ACKNOWLEDGMENTS

The authors would like to express their gratitude and appreciation to all who contributed to this study, directly or indirectly.

REFERENCES

Adejumo, O. (2002). Developmental Strategy for Sustainable Public Open Space System in Metropolitan Lagos. In D. Amole, A. Ajayi, & A. Okewole, *The City in Nigeria: Perspectives, Issues, Challenges & Strategies,* pp. 112–120. Ile-Ife: Obafemi Awolowo University, Ile Ife. Nigeria.

Akintoye, V., & Opeyemi, O. (2014). Prospects for Achieving Sustainable Development Through the Millennium Development Goals in Nigeria. *European Journal of Sustainable Development*, 33-33.

Aluko, O. (2011). Development Control in Lagos State: An Assessment of Public Compliance to Space Standards for Urban Development. *International Multidisciplinary Journal, Ethiopia*, pp. 169–184.

Angelidou, M., & Psaltoglou, A. (2017). Empirical Investigation of Social Innovation Initiatives for Sustainable Urban Development. *Sustainable Cities and Society*, 13-125.

Bashorun, J. O., & Ayeni, D. A. (2013). Planning and restoration of environmental values in Nigeria's dysfunctional societies. *European journal of sustainable development*, 184-198.

Basiri, M., Azim, A., & Farrokhi, M. (2017). Mart City Solution for Sustainable Urban Development. *European Journal of Sustainable Development*, pp. 71–84.

Cooke, P. (2017). Complex spaces. *Journal of Open Innovation*, pp. 9–11.

David, O. A., & Senem, Z. S. (2017). Accessibility of Public Spaces: Case Study of Ikeja, Lagos State, Nigeria. *International Journal of Humanities and Social Science Invention (IJHSSI)*, 12-24.

Dimuna, K. O. (2011). The Social Effects of the Built Environment: A case study of selected buildings in Benin City. *Nigeria Journal of Human Ecology*, 189-196.

Ellis, P., & Roberts, M. (2016). *Leveraging Urbanisation in South Asia-Managing Spatial Transformations for Prosperity and Livability.* Washington, DC: World Bank.

Emordi, E. (2005). The emergence of the 'Area Boys' phenomenon in Lagos, Nigeria, the constitution. *A Journal of Constitutional Development, Lagos*, pp. 61–88.

Esan, O. (2021). City Chimerism: A Critic of Urban Identity Crisis in Lagos State. In T. Adejumo, & T. Shittu, *Architectural Confluence: Yesterday, Today and Tomorrow. A Festschrift for Professor Joseph Igwe,* 162-172. Lagos: Architecture & Urbanism Research Hub.

Jegede, F., Adewale, B., & Olaniyan, O. (2019). Evaluation of Sustainable Urban Renewal Strategies in an Evolving Residential District of Lagos Island, Nigeria. *International Conference on Energy and Sustainable Environment*, 1-14.

Jegede, F., Ibem, E., & Oluwatayo, A. (2018). Manifestation of Defensible Space in Lagos State Development and Property Cooperation Housing Estates, Lagos, Nigeria. *International Journal of Civil Engineering and Technology (IJCIET)*, 491-505.

Johnson, S. (2010). *The History of the Yorubas.* Cambridge: Cambridge University Press.

Kingsley, O. D., & Omatsone, M. (2010). Regeneration in the Nigerian Urban Built Environment. *Journal of Human Ecology*, 141-149.

Kitchin, R., TP, L., & McArdle, G. (2015). Knowing and governing cities through urban indicators, city benchmarking and real-time dashboards. *Regional Studies, Regional Science*, pp. 6–28.

Leah, V. G. (2020). Regenerative - The New Sustainable? *Sustainability*, pp. 1–19.

Michael, O. A. (2009). Revitalising Urban Public Open Spaces. *Journal of Geography and Regional Planning*, pp. 051–054.

Ndidi, O., & Anthony, O. (2008). They are revitalising urban public spaces in Nigeria through vegetative enclaves. *A paper presented at the National Conference on urban planning and environmental issues in the Nigerian context.* Enugu: Department of urban and regional planning, UNN.

Oduwaye, L. (2005). Residential land values and their determinants in high-density neighbourhoods of Metropolitan Lagos. *Institute of African Studies Research Review*, pp. 37–53.

Olanusi, J., Akingbohungbe, D., & Ogunruku, M. (2017). Urban Open Space Management and Implications on Environmental Quality of Lagos Satellite Towns. *Journal of Geography, Environment and Earth Science International*, 1-9.

JOURNAL OF ARCHITECTURE, PLANNING & CONSTRUCTION MANAGEMENT
Volume 14 Issue 2, 2024 E-ISSN: 2462-2222 ISSN: 2231-9514

UNDERSTANDING THE MULTI-FUNCTIONAL NATURE OF PUBLIC OPEN SPACE, A CASE STUDY AT KLCC PARK, KUALA LUMPUR, MALAYSIA

Received: 11 July 2024 | Accepted: 8 August 2024 | Available Online: 7 December 2024
DOI: 10.31436/japcm.v14i2.880

Muhammad Asyraf Aizat Bin Kapeli[1], Nurhayati Abdul Malek[2*]

[1]Centre Studies of Landscape Architecture, College of Built Environment, Universiti Teknologi MARA (UiTM) Kampus Puncak Alam, asyrafaizat00@gmail.com
[2]Centre Studies of Landscape Architecture, College of Built Environment, Universiti Teknologi MARA (UiTM) Kampus Puncak Alam, nurhayati8203@uitm.edu.my

Corresponding author: **Nurhayati Abdul Malek*
Corresponding author's email: nurhayati8203@uitm.edu.my

ABSTRACT

Public open spaces are essential in urban areas, performing various functions and services that benefit individuals and communities. This paper examines the multi-functionality of his KLCC Park public open space in Kuala Lumpur, Malaysia. KLCC Park is a vast, well-kept park in the heart of Kuala Lumpur. Recreational facilities within the park include playgrounds, jogging trails, and lakes. Picnics, family gatherings and cultural activities are also common here. This study aims to delve into the multi-functional nature of public open spaces and elucidate the importance of nature in creating a harmonious relationship between humans and their environment. The main objective is to investigate the relationship between public open space and the muti-functionality of nature; the second is to comprehend nature's significance in public open spaces and its impact on human well-being; and finally, the third objective is to suggest the incorporation of nature elements in the design and planning of public open spaces to optimise their functionality and enhancing user's overall satisfaction. The research results will help develop a more evidence-based urban planning and design approach. The article argues that public spaces should be constructed and managed to benefit individuals and communities maximum. Additionally, this contribution emphasises the importance of incorporating natural elements into the design and planning of public open spaces.

Keywords: Public Open Spaces, Multi-functionality, Nature, KLCC Park, Health

1.0 INTRODUCTION

Public open spaces play a pivotal role in urban environments, offering a range of functions and services that contribute to the well-being of individuals and communities. Among these spaces, KLCC Park in Kuala Lumpur, Malaysia, is a significant example of a public open space that has become an integral part of the city's landscape. Green open space is vital for the city because it functions as an ecological balancer and a space provider for the community to socialise (Caesarina & Saubari, 2019). This paper aims to delve into the multifunctional nature of public open spaces, explicitly focusing on KLCC Park, and elucidate the importance of nature in creating a harmonious relationship between humans and their environment.

Understanding the value and preferences urban residents have for urban greenspace attributes can contribute to planning decisions in urban landscapes to benefit both people and the environment (Roberts et al., 2022). KLCC Park, situated in the heart of Kuala Lumpur,

holds a rich heritage and cultural significance for the local community. By exploring the historical evolution of public open spaces, this paper will shed light on how these spaces have evolved and how KLCC Park, as a contemporary example, embraces and reflects the city's cultural identity.

Urban planners, designers, and policymakers must identify and understand the relationships between public open spaces and their multifunctionality. Research demonstrates a positive relationship between access to nature and natural processes of human health and well-being, as well as the role of nature in restoring cognitive processes in people (Jimenez, 2021). Recognising the diverse roles of these spaces, such as recreational, social, environmental, and cultural functions, allows for developing strategies that optimise the potential of public open spaces. By examining KLCC Park's multifunctional nature, this paper aims to uncover the intricate web of connections between various aspects and attributes of the park, providing valuable insights for the design and management of similar spaces.

The main objectives are: 1) to investigate the relationship between public open spaces, notably KLCC Park, and the multifunctionality of nature. These public open spaces support human nature, urban sustainability, environmental quality, health, and well-being (Anastasiou & Manika, 2020; Marques et al., 2020). By analysing the park's design, layout, and ecological features, the paper seeks to explore how the integration of nature contributes to the overall functioning and usability of the space. Understanding this relationship will aid in fostering sustainable urban development, enhancing the quality of life, and promoting the well-being of individuals and communities.

The second objective of this paper is 2) to comprehend nature's significance in public open spaces and its impact on human well-being. By analysing the experiences and perceptions of park visitors, this study seeks to uncover the role of nature in creating a positive and meaningful experience within KLCC Park. Connection to nature, such as that provided by urban greenspaces, directly impacts human well-being (Grilli et al., 2020), and an absence of nature within urban areas reduces access to these services (Apfelbeck et al., 2020). The findings will highlight the final objective of 3) suggestions in incorporating natural elements in the design and planning of public open spaces to optimise their functionality and enhance users' overall satisfaction.

A comprehensive research methodology will be employed to achieve the objectives:

1. Simple observational techniques will be utilised to study the patterns of park usage, human-nature interactions, and spatial arrangements within KLCC Park.
2. A survey will be conducted among park visitors to collect data regarding their experiences, preferences, and perceptions of the park's multifunctional nature.
3. Simple interviews were conducted with park users to gain insights into creating a harmonious relationship between nature and public open spaces.

Only survey data will be analysed using the Statistical Package for the Social Sciences (SPSS) software. This statistical analysis will facilitate the identification of patterns, trends, and correlations within the data, providing a quantitative understanding of KLCC Park's multifunctional nature. The results will contribute to a more evidence-based approach to urban planning and design, ensuring the public's openness.

2.0 LITERATURE REVIEW

Public open spaces are essential components of urban landscapes, serving a variety of tasks and providing several benefits to the community. Understanding the multifunctionality of public open spaces is becoming increasingly crucial for effective urban planning, community participation, and improving inhabitants' general well-being as cities get denser and more complex. This literature study investigates the multifunctionality of public open spaces, mainly focusing on KLCC Park in Kuala Lumpur. The evaluation will look at urban planning, community participation, recreational activities, social interaction, health and well-being, green infrastructure, biodiversity, and the impact of the COVID-19 epidemic on contemporary trends in public open spaces.

2.1 Benefits of Multifunctionality in Public Open Spaces

The multifunctionality of public open spaces delivers several benefits to urban communities that enhance the quality of urban life and promote sustainable development. According to Anastasiou and Manika (2020) and Apfelbeck et al. (2020), among the main advantages are that social interaction and community engagement serve as venues for cultural events, social activities, and community participation, essential for building social cohesion and fostering a sense of belonging among urban residents. KLCC Park offers ample opportunities for recreation, relaxation, and social interaction, with a significant proportion of respondents acknowledging its role in enhancing community life. Similarly, multifunctional spaces contribute to environmental sustainability by incorporating green infrastructure, promoting biodiversity, and strengthening the urban ecosystem. Exposure to nature in multifunctional public spaces has been linked to improved mental health and well-being, resilience, and adaptability. KLCC Park, for example, integrates natural elements such as greenery and water features, which not only improve the aesthetic appeal and create a calming and restorative environment that helps reduce stress but also support environmental sustainability and biodiversity and can adapt to changing needs during the pandemic times (Caesarina & Saubari, 2019; Grilli et al., 2020; Jimenez, 2021; Labuz, 2019; Li et al., 2020; Wang & Banzhaf, 2019).

2.2 Urban Planning and Design

The concepts of urban open space planning and design give a foundation for developing dynamic and functioning public areas. Understanding the connection between public open spaces and urban form is critical for influencing the cityscape. According to Labuz (2019), sustainable urban growth, focusing on retaining a coherent structure of natural features, is a crucial guideline in their growth strategy. Multifunctionality approaches in urban design emphasise integrating various activities and facilities within public areas. Understanding the value and preferences of urban residents for urban greenspace qualities can thus contribute to urban landscape planning decisions that benefit both people and the environment. Multifunctional approaches in urban design, such as those employed in the development of KLCC Park in Kuala Lumpur, focus on combining various activities and amenities within public spaces, thereby enhancing their usability and appeal to a broad range of users (Roberts et al., 2022).

2.3 Community Participation and Social Interaction

Public open spaces are essential in fostering social cohesiveness and community engagement. Urban public open spaces also allow individuals to walk outside and interact with nature and

others in ways that would not be possible in other settings (Jennings & Bamkole, 2019). Small distances from permanent residences may make the areas mentioned above more accessible to the elderly, crippled, or parents with children (Labuz, 2019). Understanding social behaviour and dynamics in public open spaces can help designers make design decisions that promote beneficial interactions. As more individuals spend the bulk of their time indoors and suffer from "nature deficits," limiting access to urban public open spaces may reduce opportunities for social engagement and the possibility of social cohesiveness (Jennings & Bamkole, 2019).

2.4 Environmental Sustainability and Green Infrastructure

The ecological benefits of public open spaces contribute to environmental sustainability. They promote urban ecosystems and biodiversity by acting as green infrastructure. Strategies such as incorporating natural plants, using sustainable materials, and installing efficient water management systems are examples of sustainable design concepts for public open spaces (Wang et al., 2019). Biodiversity (for example, birds) may also play a role. According to a recent meta-analysis, tree canopy is more beneficial to biodiversity than open grasslands (Prevedello et al., 2018). Climate resilience and adaptation methods are critical factors for ensuring open space sustainability in the face of climate change (Jennings & Bamkole, 2019).

2.5 Health and Well-being

According to the World Health Organization's Mental Health Action Plan 2013-2020 preface by Margaret Chan, MD, "good mental health enables people to realise their potential, cope with the normal stresses of life, work productively, and contribute to their communities." According to research, exposure to outdoor greenery near people's houses is linked to and plays a significant influence on their mental health and well-being (van den Bosch & Meyer-Lindenberg, 2019). Some research in Australia, for example, reveals that humans prefer higher density and moderate vegetation complexity, indicative of tree canopy over relatively simple open landscapes that are more equivalent to extensive tracts of grass (Harris et al., 2018). Design considerations such as walkability, provision of recreational amenities, and incorporation of natural elements contribute to improving health outcomes.

2.6 Economic and Cultural Perspectives

Individuals' social and economic profiles and connections created from previous cultural surroundings and situations influence their appreciation of urban open spaces (Diener et al., 2018). They draw tourists, help local businesses, and raise property values. Furthermore, increased "consumption of public goods" reflects people's desire for public amenities (Lu, 2020). Furthermore, open areas have cultural significance and contribute to a place's character. Cultural integration can be accomplished in public open spaces through creative installations, cultural events, and programmes that represent the local heritage.

2.7 Policy and Governance

Policy frameworks and norms are essential for public open space planning, management, and upkeep. Local governments ensure open spaces' availability and equal distribution. By 2020, Malaysia's National Urbanisation Policy (NUP) has set a standard to achieve two hectares of green areas for every 1000 people (Wan et al., 2023). Many locations in poorer neighbourhoods have no street trees at all. As a result, inhabitants in poorer areas are more dissatisfied with the inadequate provision and quality of public green infrastructure than

those in more affluent areas (Shackleton et al., 2018). Long-term open space sustainability requires funding approaches and policies. In China, Li et al. (2020) investigated patterns across 289 cities and discovered a positive relationship between the availability of public green infrastructure and per capita GDP. Considering more significant socioeconomic development problems, it is frequently difficult for the government to dedicate cash to urban greening efforts. However, as mentioned in the Sustainable Development Goals, there is enough data to show that the ecosystem services provided by green infrastructure are critical for socioeconomic development and overall human well-being (Venter et al., 2020).

2.8 Current Trend in Public Open Spaces: COVID-19

The epidemic of COVID-19 has had an impact on the design and use of public open spaces. Parks and public open spaces are gaining attention again because of their significant and irreplaceable roles, such as providing places for healthful outdoor leisure (Rice & Pan, 2020; Samuelsson et al., 2020). Throughout the epidemic, public open spaces have been crucial for maintaining physical and mental well-being, underlining the need for adaptable and resilient designs that can meet changing needs while also assuring user safety. Parks provide essential environmental services that alleviate some of the stress associated with COVID-19 while also ensuring humans' emotional and physical wellness.

With an emphasis on the attributes of the multipurpose public areas in KLCC Park. By examining the areas of urban planning and design, social interactions and community engagement, environmental sustainability and green infrastructure, health and well-being, economic and cultural perspectives, policy and governance, and the effect of the COVID-19 pandemic, this review offers an in-depth understanding of the factors that shape public open spaces. Combining knowledge from several fields contributes to developing impermeable standards and methods for building vibrant, long-lasting public open spaces that meet the requirements of individuals and communities.

3.0 METHODOLOGY

This section describes the approach to exploring the multifunctional character of public open spaces at Kuala Lumpur's KLCC Park. The study collects the data using a combination of surveys, simple observations, and interviews. Park users who agreed to be interviewed and surveyed were those approached at the site. SPSS analysis and descriptive statistics are used. This technique thoroughly examines the characteristics, usage patterns, and spatial distribution of public open spaces in KLCC Park.

3.1 Survey

A structured survey was distributed to park visitors to gather information about their perspectives and experiences with KLCC Park. The survey collected data on the park's functions, such as usage patterns, amenities and facilities, cultural events, and environmental issues (as presented in Table 1 below). Question topics will include park utilisation patterns, amenities used, visitor satisfaction, and suggestions for improvement. The survey will use closed-ended and open-ended questions to collect quantitative and qualitative data.

Table 1: List of survey questions

Description	Items	Variables
Section A	Multi-functionality and Experiences	KLCC Park have a various functions or purposes for the communities?
		How often you participated in any cultural events or social activities within the park?
		KLCC Park does provides opportunities for recreation, relaxation, and social interaction.
Section B	Urban Planning and Design	The design elements of KLCC Park, such as greenery, water features, and seating areas, enhance its aesthetic appeal.
		The layout and arrangement of amenities within KLCC Park promote ease of navigation and accessibility.
		KLCC Park effectively integrates diverse activities and functions within its design.
Section C	Community Participation	KLCC Park provides opportunities for community participation and social interaction.
		The availability of platforms for community feedback and engagement in shaping the future of KLCC Park enhances its overall quality and relevance.
		I believe that community involvement in the planning and design of public open spaces leads to better outcomes.
Section D	Environmental Sustainability and Green Infrastructure	The presence of greenery and vegetation in KLCC Park enhances its environmental sustainability.
		KLCC Park contributes to the overall urban ecosystem and supports biodiversity.
		I perceive KLCC Park as a sustainable and environmentally friendly public space.
Section E	Health and Well-being	Visiting KLCC Park improves my overall well-being and reduces stress.
		KLCC Park provides opportunities for physical activity and active living.
		The natural elements within KLCC Park contribute to a calming and restorative environment.
Section F	Economic and Cultural Perspectives	KLCC Park has economic value and contributes to the local economy.
		The cultural events and activities held in KLCC Park enhance its cultural significance and identity.
		KLCC Park attracts tourists and promotes cultural exchange.
Section G	Policy and Governance	I am aware of the policies and guidelines governing the planning and management of public open spaces in Kuala Lumpur.
		Local government authorities effectively manage and maintain KLCC Park.
		KLCC Park's design and management align with the policies and regulations related to public open spaces.
Section H	Current Trend in Public Open Spaces: COVID-19	KLCC Park provides a safe outdoor environment for physical distancing during the COVID-19 pandemic.
		The COVID-19 pandemic has increased my appreciation for the availability of public open spaces like KLCC Park.
		KLCC Park has adapted well to the changing needs and requirements during the COVID-19 pandemic.
Section I	Demographic Information	Age Gender Occupation Residence

The collected data will be analysed using SPSS software, employing descriptive statistics and spatial analysis techniques. Descriptive statistics will be used to calculate measures such as means, frequencies, and percentages to describe the characteristics of public open spaces within KLCC Park. This analysis will include park size, amenities, and usage patterns. Spatial analysis using GIS will enable the examination of spatial patterns, including the distribution of public open spaces within the park, their accessibility, and proximity to other amenities. Mapping and spatial visualisation techniques will illustrate these patterns and relationships.

4.0 RESULTS

This study's participants were park visitors or people who had visited KLCC Park. It included 46 park users from the study region (as presented in Table 2 below).

Table 2: Results of Demographic Section

Description	Variables	KLCC PARK N (%)
Age	13-17 years old	5(10.9)
	18-29 years old	22(47.8)
	30-45 years old	15(32.6)
	46-59 years old	3(6.5)
	> 60 years old	1(2.2)
Gender	Male	28(60.9)
	Female	18(39.1)
Occupation	Students	19(41.3)
	Office workers	13(28.3)
	Industrial workers	11(23.9)
	Institutional workers	1(2.2)
	None	2(4.3)
Residence	Johor Bahru	1(2.2)
	Kuala Lumpur	20(43.5)
	Pahang	4(8.7)
	Selangor	21(45.7)

The demographic data analysis provides valuable insights into the characteristics of respondents who participated in the study on the multifunctional nature of Suria KLCC Park in Kuala Lumpur. Most participants were between 18 and 29, with a slightly higher representation of men. Students were the most numerous occupational groups, followed by office and industrial workers. Kuala Lumpur and Selangor accounted for most of the respondents. The diverse representation of age, gender, occupation, and place of residence ensures a thorough understanding of public perceptions and utilisation of KLCC Park, laying the groundwork for interpreting research findings and drawing meaningful conclusions about its multi-functional aspects.

According to Table 3, many respondents (36 out of 46) believed that KLCC Park serves a range of community roles or goals. Most participants also agreed that the park allows recreation, relaxation, and social connection. However, fewer responders (7 out of 46) disagreed with the park's functionality. 69.6% of respondents agreed that KLCC Park is a recreation, relaxation, and social contact location. This implies that the park is mainly used for passive activities like walking, sitting, and people-watching.

Table 3: Results of Multi-functionality and Experiences Section

Description	Variables	Strongly Disagree n (%)	Disagree n (%)	Neutral n (%)	Agree n (%)	Strongly Agree n (%)
Section A	KLCC Park have a various functions or purposes for the communities?	4(8.7)	3(6.5)	3(6.5)	10(21.7)	26(56.5)
	How often you participated in any cultural events or social activities within the park?	3(6.5)	5(10.9)	6(13)	9(19.6)	23(50)
	KLCC Park does provides opportunities for recreation, relaxation, and social interaction.	2(4.3)	3(6.5)	3(6.5)	11(23.9)	27(58.7)

Overall, the study's findings indicate that KLCC Park is a well-liked and well-utilized park that offers a variety of options for recreation, relaxation, and social contact. The Park, on the other hand, might do more to promote cultural events and social activities.

Table 4: Results of Urban Planning and Design Section

Description	Variables	Strongly Disagree n (%)	Disagree n (%)	Neutral n (%)	Agree n (%)	Strongly Agree n (%)
Section B	The design elements of KLCC Park, such as greenery, water features, and seating areas, enhance its aesthetic appeal.	3 (6.5)	2 (4.3)	0 (0)	23 (50)	18 (39.1)
	The layout and arrangement of amenities within KLCC Park promote ease of navigation and accessibility.	2 (4.3)	3 (6.5)	4(8.7)	20 (43.5)	17 (37)
	KLCC Park effectively integrates diverse activities and functions within its design.	2 (4.3)	3 (6.5)	4 (8.7)	21 (45.7)	16 (34.8)

Tables 4 and 5 reveal that many respondents supported all three statements. Only 10.8% of respondents disagreed with the first statement, while 89.1% strongly agreed. 8.7% of respondents remained neutral with the second statement, compared to 82.5% who approved. 10.8% of respondents disagreed or strongly disagreed with the third statement that the design incorporates various activities and functions, compared to 80.5% who agreed or strongly agreed. It implies that respondents were largely pleased with KLCC Park's urban architecture and planning. They thought the park's design and characteristics were attractive, simple, and ideal for various activities.

Table 5: Results of the Community Participation Section

Description	Variables	Strongly Disagree n (%)	Disagree n (%)	Neutral n (%)	Agree N (%)	Strongly Agree n (%)
Section C	KLCC Park provides opportunities for community participation and social interaction.	2 (4.3)	4 (8.7)	6 (13)	24 (52.2)	10 (21.7)
	The availability of platforms for community feedback and engagement in shaping the future of KLCC Park enhances its overall quality and relevance.	3 (6.5)	2 (4.3)	8 (17.4)	26 (56.5)	7 (15.2)
	I believe that community involvement in the planning and design of public open spaces leads to better outcomes.	2 (4.3)	2 (4.3)	9 (19.6)	26 (56.5)	7 (15.2)

The survey results provide information about community engagement and social interaction in KLCC Park. While most respondents (73.9%) agreed that the park offers possibilities for community interaction, a significant number (13%) expressed indifferent or unfavourable views (4.3% disagreed, 8.7% strongly disagreed). Similarly, most participants believed that community feedback systems had a

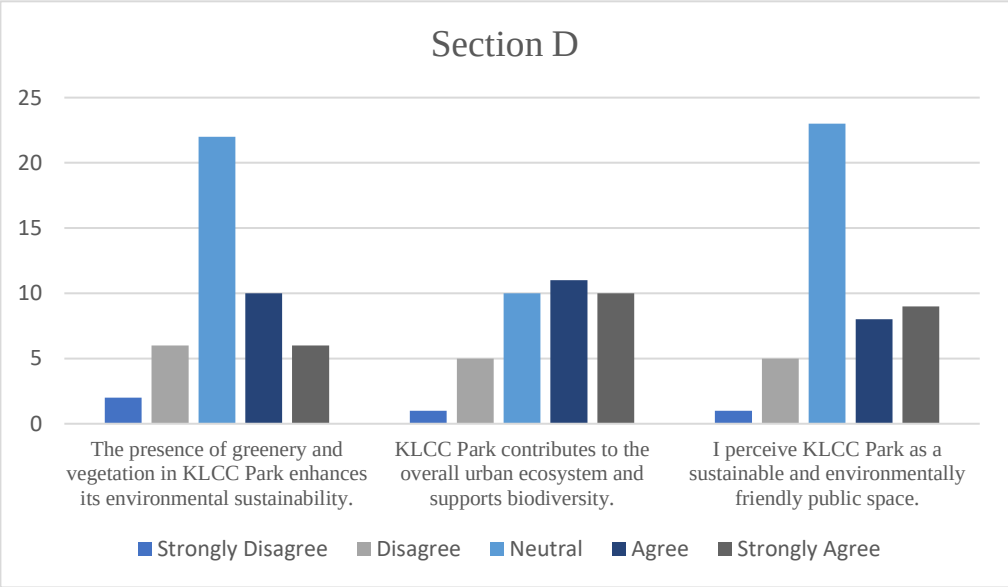

Figure 1: Results of Environmental Sustainability and Green Infrastructure Section

beneficial impact on the park's quality and relevance (56.5% agreed, 15.2% strongly agreed). However, 23.9% remained neutral, while the remainder disagreed.

Furthermore, while the majority (56.5% agreed, 15.2% strongly agreed) favoured community involvement in public open space planning, 23.9% indicated ambiguity or disagreement. Authorities might focus on improving communication, giving more apparent feedback

opportunities, and highlighting the good outcomes of community involvement in park planning and design to strengthen community engagement and address concerns.

According to the study on the environmental sustainability of KLCC Park (as presented in Figure 1 above), most respondents strongly agreed (47.8%) or (21.7%) that the presence of greenery and vegetation improves the park's environmental sustainability. However, some respondents (17.3%) were neutral or disagreed (4.3% and 13%, respectively). When asked about the park's impact on biodiversity and the urban ecosystem, 23.9% agreed, 21.7% strongly agreed, and 10.9% disagreed. Regarding KLCC Park's perception as a sustainable and environmentally friendly location, 50% were neutral, 19.6% agreed, and 13% strongly agreed. These findings show that the park's beneficial environmental features are widely recognised, but more work is needed to raise public understanding and perception of its sustainability programmes.

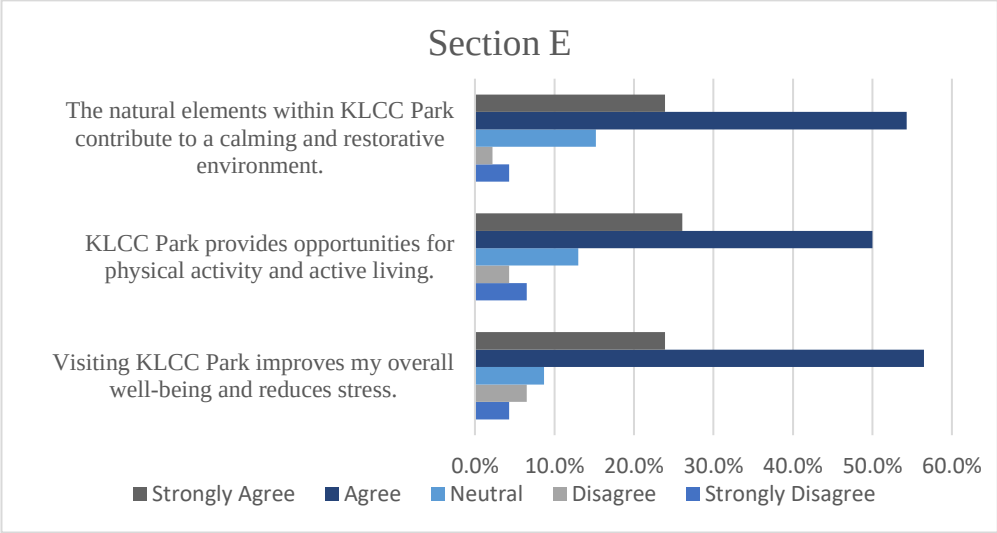

Figure 2: Results of the Health and Well-being Section

According to the study on the environmental sustainability of KLCC Park, most respondents strongly agreed (47.8%) or (21.7%) that the presence of greenery and vegetation improves the park's environmental sustainability. However, some respondents (17.3%) were neutral or disagreed (4.3% and 13%, respectively). When asked about the park's impact on biodiversity and the urban ecosystem, 23.9% agreed, 21.7% strongly agreed, and 10.9% disagreed. Regarding KLCC Park's perception as a sustainable and environmentally friendly location, 50% were neutral, 19.6% agreed, and 13% strongly agreed. These findings show that the park's beneficial environmental features are widely recognised. Still, more work is needed to raise public understanding and perception of its sustainability programmes, as presented in Figure 2 above.

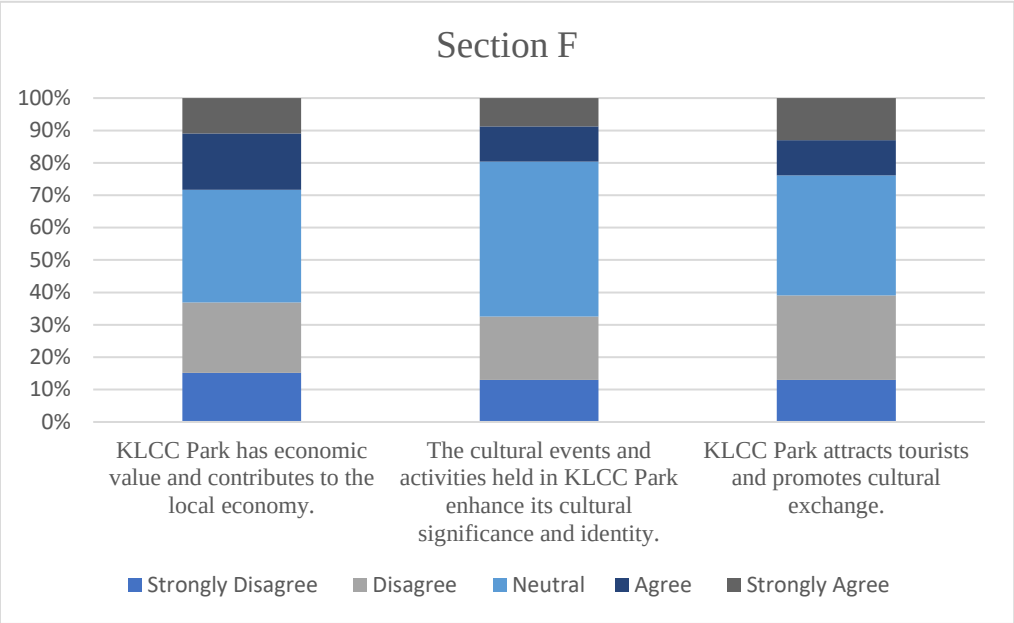

Figure 3: Results of Economic and Cultural Perspectives Section

The survey data on the economic, cultural, and tourism components of KLCC Park provides valuable insights into public perceptions (as presented in Figure 3 above). Concerning the park's economic importance and contribution to the local economy, 17.4% agreed, with 10.9% strongly agreeing. However, a sizable proportion of respondents (34.8%) expressed indifferent views, while 15.2% disagreed and 21.7% strongly disagreed with this assertion. Regarding the cultural events and activities held in KLCC Park, 10.9% agreed, and 8.7% strongly agreed, that they contribute to the park's cultural relevance and character. Meanwhile, 47.8% were undecided, 13% disagreed, and 19.6% strongly disagreed. Furthermore, in terms of attracting tourists and boosting cultural exchange, 10.9% agreed and 13% strongly agreed, whereas 37% were neutral, 13% disagreed, and 26.1% strongly opposed.

Table 6: Results of Policy and Governance Section

Description	Variables	Strongly Disagree n (%)	Disagree n (%)	Neutral n (%)	Agree n (%)	Strongly Agree n (%)
Section G	I am aware of the policies and guidelines governing the planning and management of public open spaces in Kuala Lumpur.	3 (6.5)	4 (8.7)	34 (73.9)	3(6.5)	2 (4.3)
	Local government authorities effectively manage and maintain KLCC Park.	3 (6.5)	1 (2.2)	7 (15.2)	9 (19.6)	27 (58.7)
	KLCC Park's design and management align with the policies and regulations related to public open spaces.	3 (6.5)	4 (8.7)	35 (76.1)	3 (6.5)	1 (2.2)

Based on survey data on KLCC Park's policies, management, and compliance with regulations (see Table 6 above), most respondents (73.9%) needed clarification or were ambivalent about their awareness of the governing policies and the park's design and management compliance with rules (76.1%). Most respondents (58.7%) agreed that the local government effectively manages and maintains the park. However, some were doubtful (15.2%) or disagreed (2.2%). Efforts should be undertaken to raise public awareness and understanding of the park's policies to improve public perception. Furthermore, addressing management concerns and establishing apparent compliance with legislation will boost confidence in KLCC Park's governance and build public trust in its management.

Table 7: Results of Current Trend in Public Open Spaces: COVID-19 Section

Description	Variables	Strongly Disagree n (%)	Disagree n (%)	Neutral n (%)	Agree n (%)	Strongly Agree n (%)
Section H	KLCC Park provides a safe outdoor environment for physical distancing during the COVID-19 pandemic.	2(4.3)	1(2.2)	7(15.2)	9 (19.6)	27(58.7)
	The COVID-19 pandemic has increased my appreciation for the availability of public open spaces like KLCC Park.	2(4.3)	2(4.3)	6(13)	10 (21.7)	26(56.5)
	KLCC Park has adapted well to the changing needs and requirements during the COVID-19 pandemic.	2(4.3)	2(4.3)	7(15.2)	9 (19.6)	26(56.5)

According to survey data on KLCC Park's (as presented in Table 7 above) response to the COVID-19 pandemic, a sizable proportion of respondents (58.7%) strongly agreed, and 19.6% agreed that the park provides a safe outside area for physical separation during the pandemic. Meanwhile, a lesser fraction (2.2%) disagreed or was undecided (15.2%). Furthermore, the pandemic has increased appreciation for public open areas such as KLCC Park, with 56.5% strongly agreeing and 21.7% agreeing. Only 4.3% agreed or strongly agreed, with 13% remaining neutral. Regarding the park's ability to adapt throughout the epidemic, 56.5% strongly agreed, and 19.6% agreed. A smaller proportion (4.3%) disagreed or was undecided (15.2%). These data, as well as through observation, imply that throughout the epidemic, most respondents saw KLCC Park as a safe outdoor location for physical distance and that the crisis has increased their respect for such public spaces. Moreover, many respondents felt the park reacted well to shifting needs and requirements during these difficult times.

5.0 DISCUSSIONS

The study on the multifunctional nature of Kuala Lumpur's Suria KLCC Park provided valuable insights into public perceptions and usage of the park. The demographic data analysis revealed that a big part of the participants was between 18 and 29 years old, with men having a slightly higher representation. The most numerous occupational groups were students and office and industrial workers. The survey included participants from Kuala Lumpur and Selangor, representing a diverse range of ages, gender, occupation, and place of residence among a big part of the respondents. According to the study's findings, KLCC Park is well-liked

and well-utilised, with many respondents recognising its multifunctional roles, which include recreation, relaxation, and social connection. Multi-functionality approaches in urban design emphasise integrating various activities and facilities within public areas. Where the users and functions are filtered, divided, and isolated in public places, disturbing public life (Androulaki et al., 2020); some respondents, however, expressed concerns about its functionality, indicating potential areas for improvement. Urban public open spaces should allow and enhance the individual's choices to walk outside and interact with nature and others in ways that would not be possible in other settings (Labuz, 2019).

Through simple interviews and observations, respondents overwhelmingly praised the urban architecture and planning of KLCC Park, with the vast majority strongly agreeing that the design incorporated various activities and functions. The well-designed layout and features of the park contribute to its multi-functionality and appeal, catering to a wide range of user groups. According to Roberts et al. (2022), the value and preferences of urban residents for urban greenspace qualities can thus contribute to urban landscape planning decisions that benefit both people and the environment. Community engagement and social interaction in the park elicited conflicting responses, with many agreeing that the park facilitates community interaction and others expressing indifference or disagreement. Improving communication and feedback systems can increase community engagement and effectively address concerns. Respondents recognised the park's environmental sustainability and positive impact on biodiversity and the urban ecosystem. Climate resilience and adaptation methods are critical factors in ensuring the sustainability of open spaces in the face of climate change. (Jennings & Bamkole, 2019).

The survey data on economic, cultural, and touristic aspects revealed a range of responses. While some acknowledged the park's economic and cultural significance, others disagreed. Promotional efforts can be directed towards increasing the park's cultural significance, attracting tourists, and expanding its economic significance. According to Lu (2020), People's desire for public amenities is reflected in increased "consumption of public goods". The study also stressed the significance of park policies and management. Many respondents needed clarification or ambivalent about their understanding of governing policies and their ability to comply with regulations. According to Kim and Song (2019), local governments are responsible for ensuring the availability of open spaces and equal distribution. Clear policy communication and improved management practices will instil confidence in the park's governance and foster public trust. The park's positive reaction to the COVID-19 pandemic was well received, emphasising its role as a safe outdoor space and its ability to adapt to changing needs during crises, such as the key and irreplaceable roles, such as providing places for healthful outdoor leisure (Geng et al., 2021; Rice & Pan, 2020; Samuelsson et al., 2020).

6.0 CONCLUSION

In conclusion, KLCC Park is undoubtedly a well-liked and well-utilised public open space with considerable potential for enhancing social, economic, and environmental sustainability. The study highlights the significance of community engagement, sustainability initiatives, and cultural promotion in optimising the park's multi-functionality and overall impact. As urban planners and policymakers, it is imperative to heed these findings and strive to create vibrant and inclusive public open spaces that cater to the diverse needs and preferences of the public, ensuring a harmonious relationship between humans and their urban environment. Based on the key findings discussed in this study, here are some specific recommendations that could be implemented to address the identified issues and enhance the effectiveness of public open

spaces in Malaysia. The first is to implement targeted urban greening initiatives in underserved areas, particularly in poorer neighbourhoods that lack adequate public open spaces. Local governments should prioritise these areas for new green infrastructure projects, such as parks, street trees, and community gardens.

Additionally, creating incentives for private sector investment in green spaces within these neighbourhoods could help bridge the gap in accessibility and improve the overall quality of life for residents. The second is establishing a dedicated funding mechanism for maintaining and expanding public open spaces. This could include setting up a "Green Infrastructure Fund" financed through public-private partnerships, municipal budgets, and community contributions. The fund should be specifically earmarked to keep existing parks, develop new spaces, and integrate sustainable practices such as rainwater harvesting and native plant landscaping. Third, to strengthen governance frameworks by fostering collaboration between different levels of government, non-governmental organisations (NGOs), and community groups. This can be achieved by creating local "Urban Green Councils" that unite stakeholders to oversee public open spaces' planning, implementation, and management. These councils should be empowered to make decisions that reflect the community's needs while adhering to sustainability principles.

Next, encourage greater community involvement in planning and maintaining public open spaces through participatory design processes and volunteer programs. Local governments could organise workshops, surveys, and public meetings to gather input from residents on the types of amenities and activities they would like to see in their public spaces. Additionally, establishing "Adopt-a-Park" programs could involve local businesses and residents in the stewardship of green spaces, fostering a sense of ownership and responsibility. Hence, a comprehensive monitoring and evaluation framework should be developed to assess the effectiveness of public open spaces in meeting community needs and sustainability goals. This could involve regular surveys to gather user feedback, environmental impact assessments to measure the ecological benefits of green spaces, and economic analysis to evaluate the contribution of these spaces to local economies. The data collected should inform policy adjustments and improve the design and management of public open spaces over time.

Finally, green infrastructure planning should be integrated into broader urban development strategies to ensure public open spaces are preserved and enhanced as cities grow. This could involve revising zoning laws to require a minimum percentage of green space in new developments, promoting green roofs and walls in urban areas, and connecting existing green spaces through green corridors that enhance biodiversity and provide continuous recreational opportunities. Considering these insights, we can shape a brighter, more sustainable future for KLCC Park and similar public spaces worldwide and ensure that public open spaces are more equitable, sustainable, and responsive to the needs of all urban residents.

ACKNOWLEDGMENTS

This paper is part of the Landscape Architecture Research Seminar subject handled by the Department of Landscape Architecture, College of Built Environment, UiTM, Puncak Alam Campus. Acknowledgements go to the department academician and supervisor who helped make this paper a reality.

REFERENCES

Journal article

Anastasiou, E., & Manika, S. (2020). Perceptions, Determinants and Residential Satisfaction from Urban Open Spaces. Open Journal of Social Sciences, 8, 1-18. https://doi.org/10.4236/jss.2020.86001

Androulaki, M., Frangedaki, E., & Antoniadis, P. (2020). Optimisation of Public Spaces Through Network Potentials of Communities. Procedia Manufacturing, vol. 44, pp.294–301. https://doi.org/10.1016/j.promfg.2020.02.234

Apfelbeck, B., Snep, R. P.H., Hauck, T. E., Ferguson, J., Holy, M., Jakoby, C., Scott MacIvor, J., Schär, L., Taylor, M., & Weisser, W. W. (2020). We are designing wildlife-inclusive cities that support human-animal co-existence. Landsc. Urban Plan. 200, 103817 https://doi.org/10.1016/j.landurbplan.2020.103817

Caesarina, H.M. & Saubari, N. (2019). Peran Ruang Terbuka Hijau dalam Perencanaan Kota Sebagai Potensi Pembentuk Smart City. Jukung: Jurnal Teknik Lingkungan, 5(1), 28-39

Diener, E., Oishi, S., & Tay, L. (2018). Advances in Subjective Well-Being Research. Nature Human Behaviour, 2, 253-260. https://doi.org/10.1038/s41562-018-0307-6

Geng, D., Innes, J., Wu, W. (2021). Impacts of COVID-19 pandemic on urban park visitation: a global analysis. *J. For. Res.* 32, 553–567. https://doi.org/10.1007/s11676-020-01249-w

Grilli, G., Mohan, G. & Curtis, J. (2020). Public Park Attributes, park visits, and associated health status, Landscape and Urban Planning, Volume 199, 103814, ISSN 0169-2046, https://doi.org/10.1016/j.landurbplan.2020.103814

Harris, V., Kendal, D., Hahs, A. & Threlfall, C. (2018). Public open space context and vegetation complexity shape people's preferences for urban public parks and residential gardens. Landsc Res. 2018;43(1):150-162. doi:10.1080/01426397. 2017.1302571

Jennings, V., & Bamkole, O. (2019). The Relationship between Social Cohesion and Urban Public Open Space: An Avenue for Health Promotion. *International Journal of Environmental Research and Public Health*, *16*(3), 452. MDPI AG. Retrieved from http://dx.doi.org/10.3390/ijerph16030452

Jimenez, M. P., DeVille, N. V., Elliott, E. G., Schiff, J. E., Wilt, G. E., Hart, J. E. & James, P. (2021). Associations between Nature Exposure and Health: A Review of the Evidence. Int. J. Environ. Res. Public Health 2021, 18, 4790. https://doi.org/ 10.3390/ijerph18094790

Kim, D., & Song, S.K. (2019). The Multifunctional Benefits of Green Infrastructure in Community Development: An Analytical Review Based on 447 Cases. *Sustainability*, *11*(14), 3917. MDPI AG. Retrieved from http://dx.doi.org/10.3390/su11143917

Labuz, R. (2019) IOP Conf. Ser.: Mater. Sci. Eng. 471 112018. DOI 10.1088/1757-899X/471/11/112018

Li, X., Ma, X., Hu, Z. & Li, Siyuan. (2020). Investigating urban public open space equity at the city level and relevant strategies for improving the provisioning in China. Land Use Policy. 101. 105144. 10.1016/j.landusepol.2020.105144.

Lu, L. (2020). Review of Western Research on Demand Recognition of Public Product. Open Journal of Social Sciences, pp. 8, 167–176. https://doi.org/10.4236/jss.2020.84012

Marques, B., McIntosh, J. & Chase, V. (2020). Improving Community Health and Wellbeing Through Multi-Functional Green Infrastructure in Cities Undergoing Densification. Acta Horticulturae et Regiotecturae,23(2) 101-107. https://doi.org/10.2478/ahr-2020-0020

Prevedello, J. A., Almeida-Gomes, M. & Lindenmayer, D. B. (2018). The importance of scattered trees for biodiversity conservation: a global meta-analysis. *J Appl Ecol*. 55(1):205-214. doi:10.1111/1365-2664.12943

Rice, W. L., & Pan, B. (2020, May 19). Understanding drivers of change in park visitation during the COVID-19 pandemic: A spatial application of Big data. https://doi.org/10.31235/osf.io/97qa4

Roberts M., Glenk K., & McVittie A. (2022). Urban residents value multi-functional urban greenspaces, Urban Forestry & Urban Greening, Volume 74, 127681, ISSN 1618-8667, https://doi.org/10.1016/j.ufug.2022.127681.

Samuelsson, K., Barthel, S., Colding, J., Macassa, G., & Giusti, M. (2020, April 17). Urban nature as a source of resilience during social distancing amidst the coronavirus pandemic. https://doi.org/10.31219/osf.io/3wx5a

Shackleton, C. M., Blair, A., De Lacy, P., Kaoma, H., Mugwagwa, N., Dalu, M. T., & Walton, W. (2018). How important is green infrastructure in small and medium-sized towns? Lessons from South Africa. Landscape and Urban Planning, pp. 180, 273–281. https://doi.org/10.1016/j.landurbplan.2016.12.007

Wang, R., Helbich, M., Yao, Y., Zhang, J., Liu, P., Yuan, Y., & Liu, Y. (2019). Urban greenery and mental wellbeing in adults: Cross-sectional mediation analyses on multiple pathways across different greenery

measures. *Environmental Research*, *176*, 108535. https://doi.org/10.1016/j.envres.2019.108535
van den Bosch, M., & Meyer-Lindenberg, A. (2019). Environmental Exposures and Depression: Biological Mechanisms and Epidemiological Evidence. *Annual review of public health*, *40*, 239–259. https://doi.org/10.1146/annurev-publhealth-040218-044106
Venter, Z., Shackleton, C., Staden, F. V., Selomane, O. & Masterson, V. (2020). Green Apartheid: Urban green infrastructure remains unequally distributed across income and race geographies in South Africa, Landscape and Urban Planning, Volume 203, 103889, ISSN 0169-2046, https://doi.org/10.1016/j.landurbplan.2020.103889

Company and Industry Reports

Wan Azlina Wan Ismail (September 26th 2023). Unwind and Connect: Creating Safe and Inclusive Spaces in Urban Districts of Malaysia. In Sustainable Infrastructure, URBANET. https://www.urbanet.info/safe-inclusive-public-spaces-urban-districts-malaysia/
World Health Organization. (2013) Mental Health Action Plan 2013–2020. Geneva, Switzerland: World Health Organization. https://www.who.int/publications/i/item/9789241506021

JOURNAL OF ARCHITECTURE, PLANNING & CONSTRUCTION MANAGEMENT
Volume 14 Issue 2, 2024 E-ISSN: 2462-2222 ISSN: 2231-9514

A STUDY ON CIRCULAR MATERIAL INFORMATION WITHIN SMALL AND MEDIUM ENTERPRISES IN MALAYSIA

Received: 23 May 2024 | Accepted: 31 July 2024 | Available Online: 7 December 2024
DOI: 10.31436/japcm.v14i2.881

Liew Yong Kian[1, 2], Fadzli Irwan Bahrudin[3], Khalilah Zakariya[4], Shamzani Affendy Mohd Din[5]

[1]Kulliyyah of Architecture and Environment Design, International Islamic University Malaysia, liew.kian@live.iium.edu.my*
[2] School of Media, Arts and Design, Asia Pacific University of Technology and Innovation, liew.yongkian@apu.edu.my
[3] Department of Applied Arts and Design, KAED, International Islamic University Malaysia, fadzliIrwan@iium.edu.my
[4] Department of Landscape Architecture, KAED, International Islamic University Malaysia, khalilah@iium.edu.my
[5] Department of Applied Arts and Design, KAED, International Islamic University Malaysia, shamzani@iium.edu.my

Corresponding author: **Liew Yong Kian*
Corresponding author's email: liew.kian@live.iium.edu.my

ABSTRACT

Exploring and utilising sustainable materials, currently known as circular materials, is a prominent strategy to shift to a circular economy. Today, Malaysia's manufacturing and design industries have started to develop by-products and second-life waste materials and incorporate them into products. The idea is to maintain the technical and biological resources in the usage loop, preventing them from leaking into landfills. However, understanding the experiential qualities of such materials still needs to be explored. Although existing research indicates an early and active development of circular materials in Malaysia, there needs to be a greater understanding of how users will experience the materials. Specifically, this study investigates the life cycle information of waste materials that is communicated to users. A dataset of a hundred-seventeen product cases indicates that information within the 'resource' and 'end-of-life' phases is dominant. Such information helps frame the message of the materials' sustainability, but the absence of holistic lifecycle information makes the materials' biography less engaging. The findings denote that the material developers have invested in developing or utilising the technical qualities of the materials, but more emphasis on the experiential qualities is needed. An engaging material experience may secure a successful uptake of circular materials in the market.

Keywords: Circular Economy, Circular Materials, Materials Biography, Material-Experience

1.0 INTRODUCTION

Plastic waste has become a global crisis, ranking as the third-highest waste source worldwide (Chen et al., 2021). Its volume increases steeply with population growth and rising consumption. Plastic's versatility makes it ubiquitous – it is found in everything from textiles and cars to manufactured goods and packaging (Locock et al., 2017). Its durability, lightweight nature, and affordability have cemented its dominance across various industries.

However, the current "use and throw" mentality ingrained in the linear plastic economy has led to massive waste accumulation in landfills, severely damaging the environment. Plastic pollution spirals out of control because, despite its near-permanent lifespan, many plastic products are designed for single use. The United Nations Environment Assembly reported in February 2022 that global plastic waste generation nears 300 million tonnes annually. This staggering number highlights plastic's pervasive presence in daily life, demanding immediate change.

Planned product obsolescence, another concept in product design, further exacerbates the plastic waste problem (Zeeuw et al., 2017). Corporations discovered that selling short-lived, consumable goods generates higher profits than durable, long-lasting products. This led product developers to strategically define a product's lifespan and use less durable materials to promote repeat purchases. Consequently, estimates suggest that global plastic waste generation will reach 585 million tonnes by 2020 (Chen et al., 2021).

The COVID-19 pandemic further accelerated plastic waste generation. Plastic, ironically, served as a protector during this emergency, but its post-use impact is problematic. Globally, everyday items like food packaging, shopping bags, online shopping bubble wrap, and personal protective equipment (PPE) like aprons, gloves, and disposable masks are disposed of immediately to prevent viral spread. Additionally, many reusable products, like aprons in salons and prayer mats in shopping malls, were replaced with disposable alternatives to comply with safety protocols (Bahrudin et al., 2021).

Undeniably, efforts to combat plastic waste are underway. Relooping plastic waste and incorporating renewable materials into manufacturing processes can reduce plastic's environmental footprint, a key aspect of a circular economy. However, transforming manufacturing and design practices presents challenges akin to changing social norms. The search for superior circular materials to replace plastic remains ongoing, while consumers accustomed to plastic products must evaluate and compare new materials for adoption.

This study investigates circular material information communicated to consumers by small and medium enterprises in Malaysia. The findings will reveal the ways users are informed about the circularity of materials. Parallelly, the development and utilisation of circular materials within Malaysia's SMEs will be better understood.

2.0 LITERATURE REVIEW

2.1 Circular Economy

The traditional linear economic model of "take-make-dispose" is no longer sustainable, prompting a new approach (Braungart et al., 2007). The circular economy (CE) model offers a promising alternative for preserving Earth's finite resources. It aims to maximise the value of materials within the industrial system for extended periods, minimising waste generation (Ellen MacArthur Foundation, 2019). A crucial aspect of CE is designing products that minimise environmental and resource impact throughout their lifecycle. In essence, as Macarthur (2013) conceptualises it when a product reaches its end-of-life, its raw materials are cycled back into the system for further use.

The circular economy aligns perfectly with sustainable development aspirations by addressing the scarcity of finite resources and reducing the mountains of waste-burdening ecosystems (Ghisellini et al., 2016). Its core principles stem from ecological, environmental economics, and industrial ecology. Furthermore, it incorporates other sustainability-driven concepts like "cradle-to-cradle", "performance economy" (Stahel, 2010), and "biomimicry". Integrating "lean" and "green" production principles further optimises material flows by achieving "detoxification" and "dematerialisation"(J. et al., 1995; Joseph Fiksel, 2007). Detoxification refers to eliminating hazardous materials from production processes. At the same time,

dematerialisation focuses on reducing the material used per product unit and replacing resource-intensive, non-renewable materials with sustainably harvested and renewable alternatives.

Much research explores strategies to implement the concept of CE by optimising resources from various aspects, such as reducing the use of critical raw materials and design utilising bio-based, recycled materials or substituting them with more advantageous materials (Thilo et al., 2018; Aldo et al. Rosen, 2022). The product life cycle will consider product parts and materials used (Virtanen et al., 2017). Good use of materials at the early stages of a product's development can ensure the materials' end of life is also sustainably handled. Therefore, emphasis on the use of 'circular materials' in the product design industry is essential to ensure the progressive development of a circular economy in a country. The success of the circular economy model hinges on effective material stewardship practices. These practices include take-back schemes, material flow records, and large-scale recycling initiatives that ensure optimal material circulation within the system.

2.2 Circular Materials

Defining material sustainability remains a complex issue due to its dependence on the viewpoints and contexts of various stakeholders. Material industry stakeholders highlight diverse sustainability dimensions, yet they converge on similar core ideas—minimising a material's negative impact on humans and the environment through efficient management.

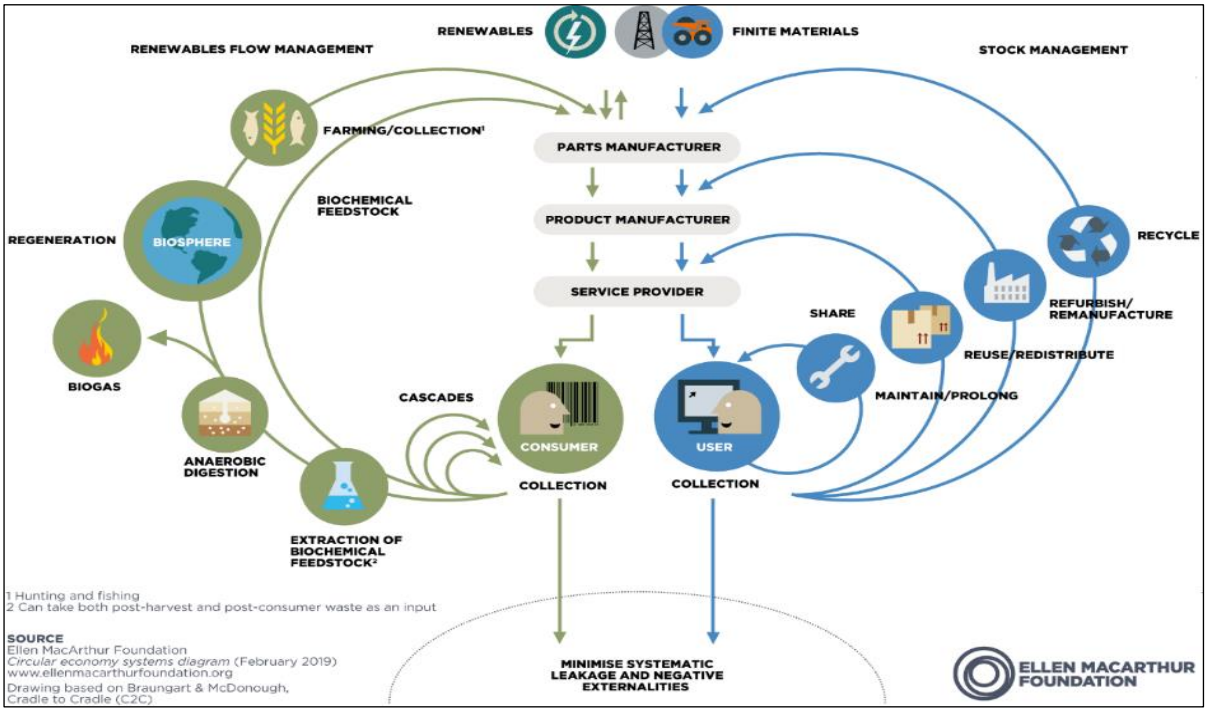

Fig. 1: The Circular Economy System Diagram (Ellen MacArthur Foundation, 2019)
(https://www.ellenmacarthurfoundation.org/circular-economy-diagram)

"Circular materials" refers to materials that meet specific circularity characteristics, regardless of their type. The defining attributes of circular materials can vary depending on the context and assessment methodology. In much research, 'Circular material' is often used

interchangeably with 'sustainable materials' and 'eco-materials' to explain the environmental credentials stressed to achieve the Circular Economy. Following the CE diagram, the circularity of materials can be classified into biological resource flow and technical resource flow (see Figure 1). An example of the biological resource flow is food packaging from natural fibre materials. It is expected that the materials will biodegrade at the end of life. In such flow, the nutrients in the material are returned to the natural environment, forming new resources for further harvest. Certain circular materials, such as paper, are worth to be recycled. Hence, for technical resource flow, materials are recycled through a cascading utilisation from high-to-low-value products (Mair et al., 2017). For example, after their lifecycle, plastic mineral water bottles can be turned into recycled plastic products and potentially into composite materials for various applications.

Fig. 2: Aspire Vero green PC made from recycled plastic by Acer.
(https://www.acer.com/ac/en/US/content/series/aspirevero)

As the product manufacturing and design industries progressively pursue the circular economy, various consumables and durable products made of circular materials have emerged. For example, Acer used 30% of post-consumer recycled plastic to produce their Aspire Vero laptop chassis (Figure 2). Besides that, following the principles of CE, the laptop is also designed to be easy to repair, upgrade and recycle. Another example is the ODGER chair of IKEA (Figure 3). The chair embodies an innovative mix of renewable wood and recycled plastic. Both products have a unique visible imperfect texture and are complemented with information that explains the 'story' of the materials.

Fig. 3: IKEA's ODGER chair is made of renewable wood and recycled plastic.
(https://www.ikea.com/se/sv/p/odger-stol-bla-00360002/)

2.3 Biographical Identity of Circular Materials

Research has demonstrated that making the products' past identity prominent boosts market demand. This phenomenon is explained by the fact that the narrative of the circular materials induces thoughts about the material biographies, which allows consumers to feel special in owning the product (Polyportis et al., 2022). Through advertisements, websites, or product labels, consumers would be informed of the material's life story, enabling them to trace the circularity of the material used in a product. For example, Adidas and Parley jointly introduced shoe designs made from recycled Ocean Plastic®. Information such as 'the shoe is made with Parley Ocean Plastic®', initially sourced from islands in the Maldives, is stated on their website.

Table 1 summarises the material biographical descriptors identified by Bahrudin (2019). A total of 29 biographical descriptors are identified within the four phases of the material lifecycle. The biographical descriptors enable researchers, designers, and product manufacturers to examine the circularity of materials used through each key point within the four lifecycle phases.

Table 1: Biographical descriptors of sustainable lifecycle

Lifecycle Phase	Biographical Descriptor	Definition	Example of information
Resource	1. Substance origin	Input material types or components of an object	Starch, plastic, paper, fibre, melamine, cellulose
	2. Object origin	The specific objects that the material was embodied into prior to being used	Cassava, corn, yoghurt cup, fishing net
	3. Provenance	The geographical location where the material comes from	United Kingdom (country), Slum of New Delhi (local area), ocean (water)
	4. Procurement source	Individual or establishment from whom the material is procured	Ragpickers, fashion industry, school children, NGOs and volunteers
	5. Material quantity	The specific number of materials or products used to make the materials	11 Pet bottles, 50% recycled materials
	6. Material availability	The specific amount of material resource that is available	2000 tonnes of bamboo production, 2 million cups a year
Production	7. Developer	The originators of the material/product	Rcup, P&G, Adidas
	8. Co-developer	The additional party that jointly developed the	Polish R&D Centre, Parley for the Ocean

Lifecycle Phase	Biographical Descriptor	Definition	Example of information
		material/product	
	9. Material development duration	The time spent on developing the material prior to the production	Six months
	10. Cultivation	The process of nurturing and growing the material	The farm relies on rainwater, not irrigation
	11. Material processer	The person / group/company that processed the material	Women's group and the community at a sheltered workshop
	12. Material processing	Procedures to transform the raw material into a product	Cleaned, dismantled, sorted, and removed unwanted materials such as batteries and textiles
	13. Material processing place	The location where the material is processed	Sheltered workshop
	14. Material-to-product producer	The stakeholders that converted the material into finished goods	P&G, Adidas
	15. Material-to-product production	Operations involved in converting the ready-material into finished goods	3D print, solar heating, synthetic binder-free, hand made
	16. Material-to-product production place	The location where the ready material is converted into finished goods	A small village in Tamil Nadu, Zurich, USA
	17. Material-to-product production date	Date indicating production batch	12-Dec-15
	18. Material technical name	The industry and scientific community recognise a name used in production and regulations to identify a substance or mixture.	Polyethene, Polyvinyl chloride, Aluminium
	19. Material trademark name	Official registered material's trademark	Ecothylene®, SpinDye®, SweeetFoam™
	20. Material nickname	Name by which a material is commonly addressed	Matrix-based felt, bio-polymer, plastic
	21. Certification	The verification of a third-party organisation regarding material's	Rainforest Alliance, Fair Trade

Lifecycle Phase	Biographical Descriptor	Definition	Example of information
		cultivation and/or production	
Use	22. Sensorial	The outcome obtained from using the material in the aspect of aesthetic	Patina, random speckled
	23. Technical	The outcome obtained from using the material in the aspect of utility performance	Flexible, water resistance
	24. Endorser	Spokespeople promoting the sustainability aspects of this material/product	Sustainability manager, celebrity
	25. Social benefit	Charitable contribution directly tied to each product consumption	Toothbrush donation for every purchase
End-of-Life	26. Collection process	The process of how the material is reclaimed or will be reclaimed	Curbside recycling, collection from the beach, take back scheme: e.g. Gimme five program
	27. Recyclability	The material's capability to be converted into new material or product	100% recyclable
	28. Compostability	The material's capability of undergoing biological decomposition in a compost site	Compost in an industrial facility
	29. Biodegradability	The material's capability to be disintegrated in the environment	Throw them in the compost pile after they wear out

3.0 METHODOLOGY

Content analysis is a well-established research method for systematically reviewing and evaluating documents. It encompasses both printed materials and electronic formats like computer-based files and internet content (Bowen, 2009). Like other qualitative research analytical methods, content analysis requires a thorough examination and interpretation of data to extract meaning, deepen understanding, and contribute to developing empirical knowledge.

This study collects information on materials from 33 small and medium enterprises that develop products from circular materials in Malaysia for content analysis. The initial dataset was taken from a study by Ismail et al. (2021). Three firms out of the 33 SMEs have been excluded from the analysis because their official website is no longer in operation. The data is collected in text and infographic form from the companies' official websites and social

media sites such as Facebook and Instagram. All the collected data from online sources were accessed from 23-30 July 2022. As a result, 117 material information cases were collected. The material information is scrutinised to identify their biographical descriptors. The types and frequency of the biographical descriptor within the information set are highlighted and recorded for analysis.

4.0 RESULTS

This section shows the result of the content analysis. Thirty-one sets of material information describing their products and circular materials used were collected from 30 of Malaysia's SMEs. Table 2 shows the types and frequency of biographical descriptors used in the material information sets.

Table 2: Frequency Used of Biographical Descriptor

Biographical Descriptor	Frequency of Used
Substance origin	32
Object origin	45
Provenance	20
Procurement source	7
Material quantity	13
Material availability	3
Developer	5
Co-developer	1
Material development duration	1
Cultivation	6
Material processor	4
Material processing	8
Material processing place	1
Material-to-product producer	15
Material-to-product production	16
Material-to-product production place	20
Material-to-product production date	0
Material technical name	11
Material trademark name	9
Material nickname	34
Certification	20
Sensorial	4
Technical	27
Endorser	0
Social benefit	16
Collection Process	0
Recyclability	8
Compostability	12
Biodegradability	20

Chart 1 shows the frequency of biographical descriptors used in the material information sets. The chart illustrates the frequency of biographical descriptors used in material information sets, offering insights into the characteristics commonly highlighted in the information provided by SMEs on their website—the chart indicating trends in the information provided about sustainable materials developed by the companies.

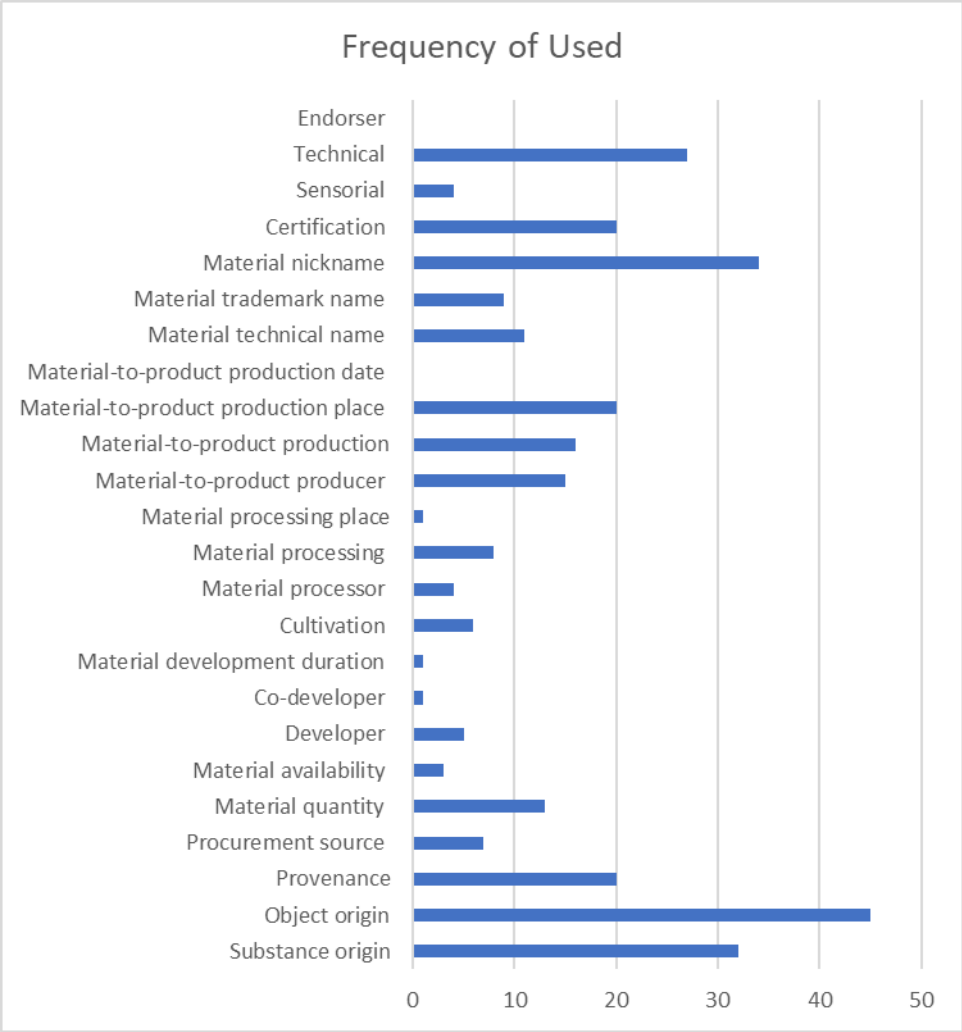

Chart 1: Frequency of biographical descriptors used in the material information sets

The biographical descriptors are then tabulated in the four phases of the product lifecycle. Figure 4 illustrates the high and low existence of descriptors in each lifecycle. In total, the biographical descriptors in the dataset are concentrated within the resource and production phases.

In the resource phase, most firms stress object and substance origin information. For the descriptors, most firms inform that they are utilising recycled materials and bio-based materials in their product. More than two-thirds of firms specify the object origin of their products, such as recycled plastic, recycled firehose, discarded PVC advertising banners, recycled paper, and used kimonos identified in the study. For substance origin, materials such as jute, corn starch, cotton, palm fibre, wheat lignin, and pineapple fibre were identified in one-third of the firms. Information on provenance, procurement source, material quantity, and availability descriptors in the information set is scarce.

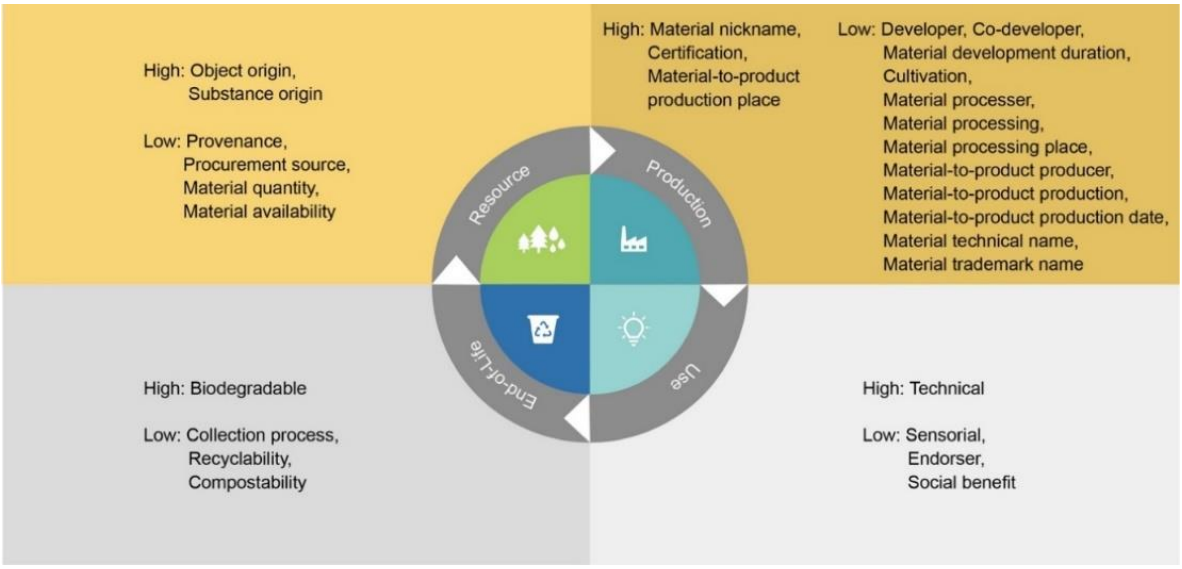

Fig. 4: The material biography analysis result is based on the lifecycle phase.

Within the production phase, several biographical descriptors exist in high frequencies. Many firms mainly provide information on material nicknames, certifications, and material-to-product production. For example, Terrae assembled their tees in their partner factory in Kuala Lumpur, Malaysia, using organic cotton and dye made in Bangladesh and certified by Organic Content Standard (OCS). Meanwhile, information on developer, co-developer, material development duration, cultivation, material processor, material processing, material processing place, material-to-product producer, material-to-product production, material-to-product production date, material-technical name, and material trademark name is limited.

In the use phase, most firms only highlight the technical benefits of utilising circular materials rather than the sensorial and social aspects. Emphasis is placed more on a material's functional qualities, such as water resistance, durability, non-toxicity, and moisture absorption advantages. More information is needed to endorse the materials.

The highly used bio-based materials have repeatedly mentioned biodegradable descriptors in the end-of-life phase—firms such as Bejute, Eco Friend, Fuze Ecoteer and Live Cube Global Sdn. Bhd. is a firm that informs its product users of the biodegradability of the materials used in its products. On the other hand, the collection process, recyclability, and compostability aspects at the end-of-life phase should be more emphasised.

5.0 DISCUSSION

Analysis shows a significant need for more detailed information regarding the circularity of materials used by Malaysian small and medium enterprises (SMEs). Currently, most SMEs provide only basic details like "recycled plastic" or generic nicknames for familiarity (e.g., rubberwood, wastepaper).

The utilisation of circular materials among SMEs is in its infancy but is still progressive. Nevertheless, the types of materials in the dataset align with the study in that they indicate scarce recycling activities. Most firms show evidence of utilising more than two types of circular materials in their products. However, as most firms' output is consumer-based

products every day, the lack of material information may hinder the uptake of the products in the market. The firms may need to craft stronger material narratives by incorporating descriptors that largely contribute to experiential aspects of circular materials, such as material resource, provenance, material production process, and sensorial. Additionally, using endorsers may solidify the green or circular image of the products. Such information enables a better appraisal, leading to a favourable uptake of the materials in the market.

Despite this, the scarcity of detailed information may hinder consumer acceptance, particularly for everyday products. To improve market uptake, SMEs should consider crafting stronger "material narratives" that incorporate specific details contributing to the experiential aspects of circular materials. This could include information on material sources, provenance, production processes, and sensory qualities. Leveraging endorsements could further solidify the green or circular image of their products. Richer material narratives enable consumers to assess the products better, potentially leading to a more favourable market response.

Our findings suggest that many SMEs in the dataset may be using readily available circular materials to create products rather than developing them from scratch. The data contains limited information on material cultivation and development processes, which is unsurprising considering that many Malaysian SMEs operate as Original Equipment Manufacturers (OEMs) with limited control over material circularity.

The study's results only reflect the information companies present on their websites. This reliance on online content analysis limits the findings, as the information may only partially represent the companies' holistic situations. Future research could incorporate user experience studies to gain a more complete picture. These studies could directly collect feedback on how users perceive information presented in a certain way. For example, a user experience study could explore consumer reaction patterns to information about products made with recycled materials. This approach would provide valuable insights to complement the online content analysis. Future research could also use focus groups with industry practitioners to triangulate these findings. This can provide a clearer picture of the actual breadth of circular material development and utilisation within the Malaysian product industry.

6.0 CONCLUSION

A linear take-make-throw concept is no longer a tenable approach in the production industry. Hence, securing resource flows through developing and utilising circular materials, such as renewable and waste materials, has become an important agenda. This study has found that many SMEs in Malaysia utilise circular materials in their products. The findings indicate an early but positive development that paves the way toward an ideal circular economy in Malaysia. However, the way the materials are communicated to users needs improvement. It is a fact that the adoption of new or non-conventional materials will be subject to users' critical evaluation. Hence, holistic lifecycle descriptors that send an enticing message about the materials' circularity are essential. Additionally, the data shows that the firms are product makers or industries that convert materials into products. However, little evidence portrays that the firms are the developers of the materials.

REFERENCES

Aldo Alvarez-Risco, & Marc A. Rosen. (2022). Towards a Circular Economy (Shyla Del, Aguila, & Arcentales, Eds.). Springer.

Bahrudin, F. (2019). The Experiential Dimension of Sustainable Materials. Imperial College London.

Bahrudin, F., Suib, S., & Mahat, M. M. (2021, March 8). A planet in distress with discarded face masks and disposable plastics. New Straits Times.

Bowen, G. A. (2009). Document analysis as a qualitative research method. Qualitative Research Journal, 9(2), 27–40. https://doi.org/10.3316/QRJ0902027

Braungart, M., McDonough, W., & Bollinger, A. (2007). Cradle-to-cradle design: creating healthy emissions – a strategy for eco-effective product and system design. Journal of Cleaner Production, 15(13–14), 1337–1348. https://doi.org/10.1016/J.JCLEPRO.2006.08.003

Chen, H. L., Nath, T. K., Chong, S., Foo, V., Gibbins, C., & Lechner, A. M. (2021). The plastic waste problem in Malaysia: management, recycling and disposal of local and global plastic waste. In SN Applied Sciences (Vol. 3, Issue 4). Springer Nature. https://doi.org/10.1007/s42452-021-04234-y

Ellen MacArthur Foundation. (2019, February). The Circular Economy System Diagram.

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. Journal of Cleaner Production, 114, 11–32. https://doi.org/10.1016/j.jclepro.2015.09.007

Ismail, Z. H., Yong Kian, L., Bahrudin, F. I., & Daud, N. (2021). Sustainable Materials in Malaysia: A Systematic Review on Academic Research and Application in Product Design Industry. The 2nd International Conference on Design Industries and Creative Cultures, August.

J. C. van Weenen. (1995). Towards sustainable product development. Journal of Cleaner Production, 3(1), 95–100.

Joseph Fiksel. (2007). Sustainability and Resilience: Toward a Systems Approach. IEEE Engineering Management Review, 2(3), 5–5.

Locock, K., Deane, J., Kosior, E., Prabaharan, H., Skidmore, M., & Hutt, O. (2017). The Recycled Plastics Market: Global Analysis and Trends. 1–60.

Macarthur, E. (2013). Towards The Circular Economy - Economic and business rationale for an accelerated transition. In Journal of Industrial Ecology.

Mair, C., & Stern, T. (2017). Cascading Utilization of Wood: A Matter of Circular Economy? In Current Forestry Reports (Vol. 3, Issue 4, pp. 281–295). Springer International Publishing. https://doi.org/10.1007/s40725-017-0067-y

Polyportis, A., Magnier, L., & Mugge, R. (2022). Guidelines to Foster Consumer Acceptance of Products Made from Recycled Plastics. Circular Economy and Sustainability. https://doi.org/10.1007/s43615-022-00202-9

Stahel, W. R. (2010). Sustainability and the Performance Economy. In W. R. Stahel (Ed.), The Performance Economy (pp. 269–287). Palgrave Macmillan UK. https://doi.org/10.1057/9780230274907_5

Virtanen, M., Manskinen, K., & Eerola, S. (2017). Circular Material Library. An Innovative Tool to Design Circular Economy. Design Journal, 20(sup1), S1611–S1619. https://doi.org/10.1080/14606925.2017.1352685

Zeeuw van der Laan A., & Aurisicchio M. (2017). Planned Obsolescence in The Circular Economy. Product Lifetimes and Environment, 446–452.

JOURNAL OF ARCHITECTURE, PLANNING & CONSTRUCTION MANAGEMENT
Volume 14 Issue 2, 2024 E-ISSN: 2462-2222 ISSN: 2231-9514

KEPONG BOTANICAL GARDEN: THE ROLE AND CHALLENGE TOWARDS CONSERVATION PLANT DIVERSITY

Received: 11 Jun 2024 | Accepted: 08 Nov 2024 | Available Online: 07 Dec 2024
DOI: 10.31436/japcm.v14i2.886

Nur Nabilah Mohd Radi[1*], Zainul Mukrim Bin Hj. Baharuddin[1], Jasasikin Ab Sani[1]

[1] Kulliyah of Architecture & Environmental Design, International Islamic University Malaysia, zainulm@iium.edu.my*
[2] Kulliyah of Architecture & Environmental Design, International Islamic University Malaysia, jasasikin@iium.edu.my*

**Corresponding author:*
Nur Nabilah bt Mohd Radi
Corresponding author's email: nnabilahradi@gmail.com

ABSTRACT

The rapid loss of plant diversity poses a critical global environmental challenge, particularly in biodiverse regions like Malaysia, encompassing diverse ecosystems from underwater realms to mountain forests. This study explores the pivotal role of botanic gardens as environmental stewards amidst this crisis, focusing on their efforts in plant conservation. This research identifies key findings through a documentation analysis of Npark Singapore Botanic Garden and Bogor Botanic Garden and semi-structured interviews with experts from Kepong Botanical Garden and Landscape Architects. Both case studies highlight the success of botanical gardens in collecting, preserving, and conserving the diversity of tropical plant species. They provide essential facilities and employ management strategies such as ex-situ conservation programs. Interviews underscore the significance of these activities in advancing plant taxonomy and habitat exploration. These findings serve as a critical reference for ongoing conservation initiatives, emphasising the potential of Kepong Botanic Garden to mitigate biodiversity loss in Malaysia.

Keywords: Botanic Garden, plant diversity, conservation, roles and challenges, Kepong Botanic Garden

1.0 INTRODUCTION

The use of botanical gardens and their social roles have shifted over time as they are entirely different from other 'green spaces'. In the 16th century, they were used to study medicinal plants. Moving to the 17th to 19th centuries, they expanded to Asia, America, and Africa, becoming hubs for introducing, cultivating, and spreading economically significant plants (e.g., rubbers, palm). In the 20th century, the need to protect biodiversity and promote sustainable use became more substantial and prominent (Spencer & Cross, 2017). According to Pimm and Raven (2017), recent estimates from the Royal Botanical Garden Kew in 2016 indicate that roughly 391,000 plant species are known to science, of which approximately 21% are nearing

Extinction. This data is supported by Tilman and Lehman (2001), where Earth is undergoing rapid and drastic loss in its plants' diversity and ecological ecosystem. It impacts all levels: local, regional, national, and international. Malaysia has the most remarkable plant diversity, yet it faces biodiversity loss faster than it can be replaced (Heywood, 2019).
Botanical gardens are viewed as breathtaking green spaces with uncommon trees and flowers and laboratories where specialists work with plants. However, the botanical garden is more than these as it holds documented living plant collections for scientific research, conservation,

display, and education (Bennett, 2014). This is supported by BGCI and CBD organisation as they established a framework outlining several criteria for botanical gardens:

Table 1: BGCI and CBD criteria for a botanical garden

BGCI	CBD
• A reasonable degree of permanence.	• General conservation and sustainable usage practices
• An underlying scientific basis for the collections.	• Identification and observation
• Proper documentation of the collections, including wild origin.	• In-situ conservation
• Monitoring of the plants in the collections.	• Ex-situ conservation
• Adequate labelling of the plants.	• Utilization of the aspects of biological variety in a sustainable manner
• Open to the public.	• Research and training
• Communication of information to other gardens, institutions, and the public.	• Public education and awareness
• Exchange of seeds or other materials with other botanical gardens, arboreta, or research institutions.	• Availability of genetic resources
• Undertaking scientific or technical research on plants in the collections.	• Information Sharing
• Maintenance research programs in plant taxonomy in associate herbaria.	• Technical and scientific collaboration

Sources: Smith and Harvey-Brown (2018). BGCI technical review: botanic gardens' economic, social, and environmental impacts.

To ensure a high-quality botanical garden standard in conserving plant diversity, these gardens must adhere to the guidelines provided by organizations such as BGCI (Botanic et al.) and the CBD (Convention on Biological Diversity). These guidelines serve as an indispensable manual for ensuring botanical gardens' efficiency, as Smith and Harvey-Brown (2018) indicated. Research also underscores the challenges and obstacles that hinder the accuracy and effectiveness of plant conservation programs in botanical gardens. This includes the difficulty of preserving all plant species and their ecosystems in the face of environmental changes, as noted in the study by Pimm and Joppa in 2015. Therefore, with its diverse collections, a botanical garden is one of the alternatives that can provide some solutions for saving plant diversity and ensuring that it can be conserved and benefit all.

2.0 LITERATURE REVIEW

Botanical gardens came with the idea and were comfortable with their status as environmental caretakers but with specific locations and operations depending on their needs (Lashley, 2012). The botanical garden has responded differently based on its geographical and physical setting, with the sorts of species, functions, and needs of the plant diversity. The natural setting's value may differ and be variable. Now, the botanical garden is also one of the major tourist sites, attracting an estimated 500 million tourists each year. As seen above, botanical gardens have recently emerged as major participants in both the conservation of flora and the education of visitors (BGCI, 2019). Based on the diagram illustrated below, the botanical garden's primary and supporting functions are now practised based on their requirements and needs.

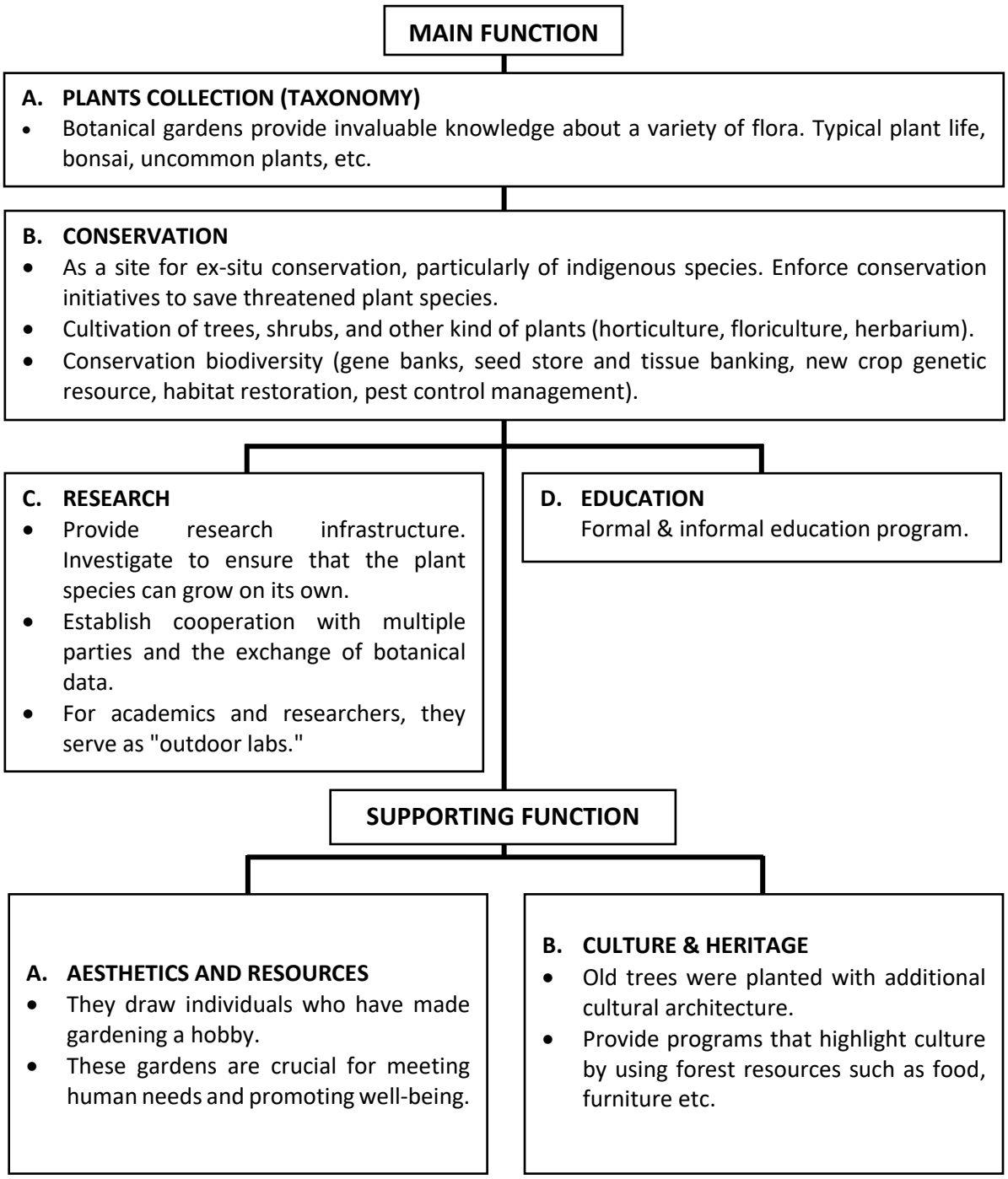

Fig. 1: The mixed functions of botanical garden

In short, a botanical garden has a unique and mixed theme. Most botanical gardens now require more profound studies, strategies, and effective management to develop and fulfil visitor experiences, and at the same time, they must effectively convey their importance as a conservation hub for plant diversity (Dodd & Jones, 2010).

2.1 Approaches Conservation Act in Botanical Garden (Integrated Plant Conservation)

When discussing conservation approaches, in-situ and ex-situ conservation activities are becoming increasingly common in many botanical gardens. In-situ means "on-site," and in-situ conservation means preserving various species in their natural habitats and ecological systems. Meanwhile, ex-situ conservation concentrates on preserving species by storing them in seed banks or living collections (Chen & Sun, 2018).

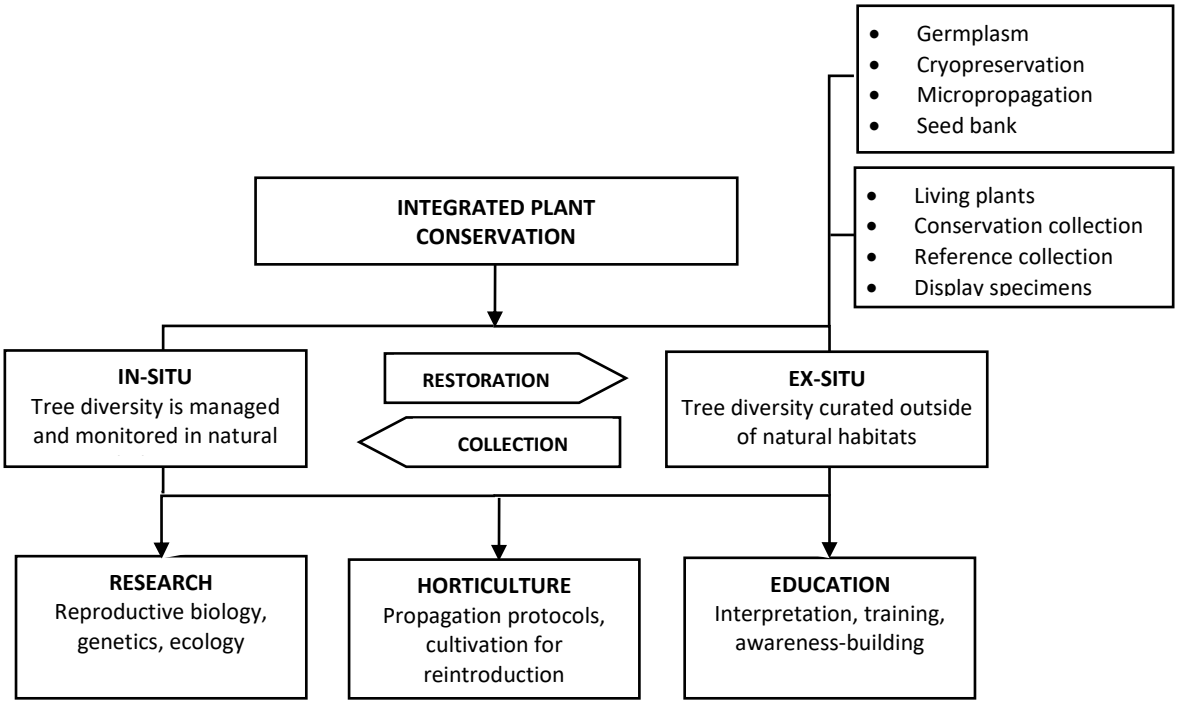

Fig. 2: Integrated plant conservation
(Source: https://www.bgci.org/about/botanic-gardens-and-plant-conservation/)

Therefore, it is crucial to simultaneously develop in-situ (on-site) and ex-situ (off-site) conservation strategies that support and reinforce each other. This combined approach, termed "integrated plant conservation," involves coordinating in-situ and ex-situ methods alongside scientific research, horticultural practices, and educational outreach. By integrating these approaches, conservation initiatives can be significantly enhanced and more effective in safeguarding plant species and biodiversity (Havens et al., 2014).

3.0 METHODOLOGY

This study incorporates comprehensive document analysis, thorough site investigations, and in-depth semi-structured interviews to gather rich, detailed qualitative data.

The document analysis focused on gathering and categorising data about botanical gardens' role as environmental stewards and studying the conservation assessment regarding conservation prioritisation. Based on case studies, a checklist of botanical garden characteristics was produced and used as a guideline to study the essential elements of the botanical garden.

Table 2: Research objective of the study

RESEARCH OBJECTIVES	METHOD	DOCUMENTS / PARTICIPANTS
1. To identify the function and challenge of Kepong Botanical Garden.	• Document analysis • Site investigation	• 2 Case studies: Npark Singapore Botanical Garden & Bogor Botanical Garden • Koleksi Pokok Taman Botani Kepong, 2018)
2. To identify the strategy and conservation approach that has been used to tackle the loss of plant diversity.	• Document analysis • Site investigation • Semi-structured interview	• **KBG 1, KBG 2 and KBG 3** are the representatives from the Kepong Botanical Garden • **NLD** is the representative of the National Landscape Department • **ILAM** is the Institute of Landscape Architects Malaysia

The Npark Singapore Botanical Garden and the Bogor Botanical Garden were chosen as references due to their significance as successful botanical gardens with rich histories. The Npark Botanical Garden is in Singapore, while the Bogor Botanical Garden is in Bogor City, West Java Province, Indonesia. Both gardens have similar climates and tropical plant diversity, and their proximity to the Kepong Botanical Garden makes it easier to study conservation efforts and challenges within the Asian context.

Fig. 3: Npark Singapore Botanic Garden
Source:Https://Edition.Cnn.Com/Travel/Article/Singapore-Botanic-Gardensunesco/Index.Htm Monument-Forget-Me-N

Fig. 4: Bogor Botanical Garden
Source:https://whc.unesco.org/en/tentativelists/6353/gardensunesco/index.htm monument-forget-me-n

A semi-structured interview was carried out with experts from the management team of the Kepong Botanical Garden (KBG), the National Landscape Department (NLD), and a representative from the Institute of Landscape Architects Malaysia (ILAM). This was done to assess the implementation of botanical garden elements from a Malaysian perspective. Five interviewees from three organisations participated in the study under KBG 1, KBG 2, KBG 3, NLD 1, and ILAM 1. The study's findings enhanced the outcomes and emphasised the critical variables related to the research.

3.1 Site Study

Kepong Botanic Garden was chosen for this research because it aims to expand its plant collection and become a unique and important national botanical garden. Further details about this site study will be thoroughly discussed as the researcher analyses the findings.

Fig.5: Kepong Botanical Garden

4.0 RESULTS AND DISCUSSION

The findings were derived from a mixture of three methods: site observation, document analysis, and semi-structured interviews, emphasising two key sections corresponding to the study's aims. The study uses two case studies to support its findings through observation, and open-ended interviews provide an additional source of professional knowledge. These strategies help to provide a full comprehension of the findings. Based on the case studies, the following information was discovered:

4.1.1 Case Study

Table 3: Npark Singapore and Bogor Botanical Garden

COMPONENTS	NPARK BOTANICAL GARDEN	BOGOR BOTANICAL GARDEN
• **History**	• Singapore Botanic Gardens were established in 1859 • Represents a British tropical colonial botanic garden • Heritage buildings are established during 1867-1930 • Has 40 heritage trees (age more than 40 years old	• Bogor Botanic Gardens represents a Dutch tropical colonial botanic garden • Heritage buildings are established 1817-1884 in which much older • Has 3,700 heritage trees • 3000 individuals of more than 50-year-old trees and 700 individuals of more than 100-year-old trees).
• **Landmarks**	• Owns Tanglin Gate (c 1890)	• Owns older landmarks such as a 234-year-old tomb (c1784)
• **Sizing**	137 ha	49 ha
• **Function**	Bear their roles in conservation, research, education, and tourism	
• **Types botanical garden**	Both are categorized as Cultural Landscape	
• **Zoning**	Offer Four Core Zones I.E. • Tanglin Core: Historic Zone • Central Core Tourist & Administration Zone • Bukit Timah Core: Education & Learning Zone, And	Offers nine zones: • Living collection zone including plants, tissue cultures, seed bank, DNA bank, spore, and pollen banks as well as a forested area. • Theme gardens/vista zone.

COMPONENTS	NPARK BOTANICAL GARDEN	BOGOR BOTANICAL GARDEN
	• Tyersal Learning Forest Core: Education & Learning Zone.	• Historic zone including buildings, landmarks, artefacts, and monuments. • Education zone. • Herbarium zone for the collection of herbarium, seed and cross-section timber cut museum and spirit herbarium. • Administration zone. • Propagation zone including nurseries and tissue-culture laboratory. • Research and development zone. • Documentary collection zone i.e., library and archive room.
• **Economic value**	• Pioneers of the rubber industry at the end of 1880's • Orchid hybrids industry in the 1920s	• Pioneer of the palm oil industry. • Highest number of orchid species living collection. • The palm oil plantations distributed all over the world originated from the seven parent trees of oil palm trees *Elaeis guineensis* grown. • Indonesia is estimated to have more than 4.000 orchid species and is an ideal place for orchid exploration. • Orchid species from this area are already used as parent stocks in breeding by other countries.
• **Public awareness**	• Conducts tour guiding, workshops and monthly discussions on biodiversity, conservation, and education	• Offers education package for schoolkids called "*Wisata Flora"* (Flora Edutainment Package). • Contributes to capacity buildings such as technical workshops/trainings, and research supervisory for bachelor and postgraduate-degree students.

The case study reveals that the design and architecture of a botanical garden are significantly more complex than those of a conventional garden. According to Gratzfeld (2016), this complexity comes from the necessity to accommodate a wide range of environmental conditions suitable for various plant species, cater to the specific desires of visitors, and adhere to guidelines defining open and closed areas within the garden's layout. Table 3 compiles findings indicating that both case studies showcase collections underlining three critical elements key to a successful botanical garden. These elements are:

1. Plant taxonomy, ensuring a well-organized and scientifically accurate classification of plants.
2. Research and education facilitate ongoing botanical studies and promote knowledge dissemination among visitors and scholars alike.

3. Conservation acts align with the broader goals of environmental preservation and sustainability, mirroring the policies and guidelines set forth by Botanic Gardens Conservation International (BGCI) and the Convention on Biological Diversity (CBD).

The above table reveals that the Npark Botanical Garden and the Bogor Botanical Garden are equipped with top-notch infrastructure, featuring nurseries, greenhouses, herbaria, seed banks, and cutting-edge research facilities.
Each garden has a list of plant types, contributing to its status as a site of Exceptional Universal Value (Kebun et al., 2018). This is crucial because a botanical garden requires global recognition to survive long-term. Also, collecting living plants is key in supporting scientific study and conservation efforts (Hengky & Kikvidze, 2018).

The management and planning of a botanical garden play a crucial role in conceptualising and implementing the design and layout of the garden. This involves careful considerations of plant species, layout designs, environmental factors, sustainability, and the overall aesthetic appeal of the garden (Espírito-Santo et al.,2020). Over time, the roles and functions of botanical gardens may shift due to various factors. However, their primary role remains as stewards of the environment, particularly in addressing the loss of plant diversity. Proper management and planning are essential in creating a beautiful and functional environment while also serving the community's needs and conservation efforts. Therefore, before proceeding with any plan, it is essential to prioritise species for monitoring and management through conservation planning. These are the important elements to ensure prioritisation is based on the degree of risk each species faces, and those with more high-level threats should be given higher priority. Limited resources should be allocated to protect species in the highest-risk group (Regan et al.,2008).

4.1.2 Site Study

After reviewing both case studies, here are the findings about the researcher site study: Kepong Botanical Garden, also known as KBG. This finding will be elaborated upon with case study references.

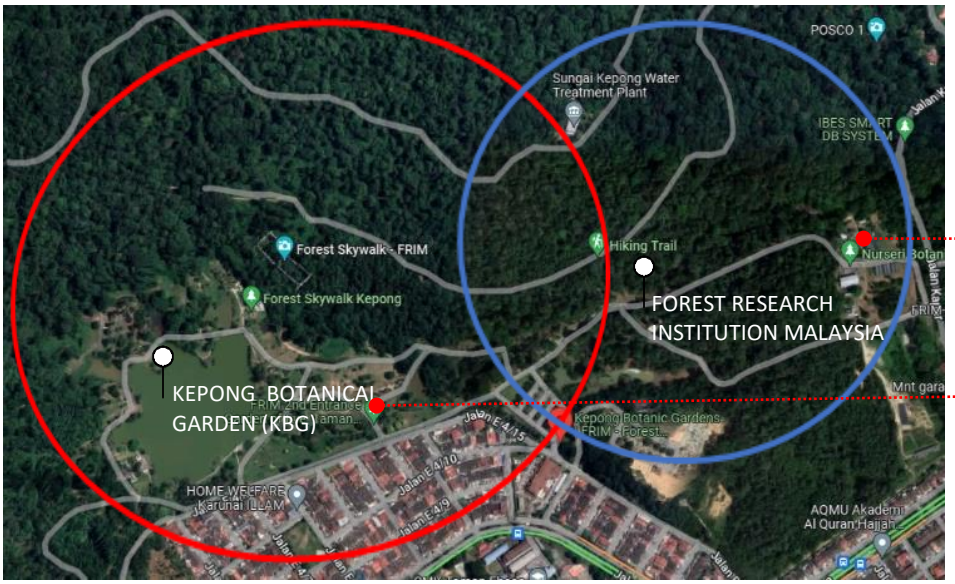

Fig.6: Map of KBG located beside FRIM

Fig.7: Entrance of FRIM

Fig.8: Entrance of KBG

Kepong Botanic Garden (KBG) is an 80-hectare garden located in Kuala Lumpur that is linked to the Forest Research Institute Malaysia (FRIM) via a dirt and paved road that runs through a nursery, providing a seamless connectivity between the two sites. The KBG and FRIM location maps are illustrated in Fig.6 above. Formerly, the establishment of KBG was to develop further FRIM's objectives in research and education in botany, horticulture, landscape, and environmental education. Its main function serves as an ex-situ conservation centre for preserving and breeding endangered, almost extinct, and endemic plant species. However, the KBG was designed with diverse applications in mind, serving as a home for living plant collections while also attracting public recreational visitors, making it a truly multi-purpose garden. This spacious area offers the opportunity for visitors to engage in activities such as jogging along the scenic trail around the lake and exploring the various collection gardens dotting the landscape. To accommodate the consistently high number of visitors, the garden has a range of amenities, including a gazebo, restroom facilities, well-marked pedestrian walkways, a floating deck for relaxation, and an information centre to guide and support guests.

Fig.9: Facilities for users

KBG recently added a new attraction: the Forest Skywalk, now open to the public. This thrilling addition allows visitors to enjoy the stunning expanse of the forest below as they gaze down from the highest tower.

Fig.10: Forest skywalk at KBG

At the same time, KBG acts as a living plant collection, where these species are allocated under an arboretum garden. According to the Koleksi Pokok Taman Botani Kepong (2018), eleven (11) theme parks have been developed, each allocating a taxonomic species to a group or family.

Table 4: Living collection at KBG

NO	THEME PARK	TYPES OF PLANT SPP.
1	Palm Collection	Coconut Palm (*Cocos nucifera*), Areca Palm (*Dypsis lutescens*), Oil Palm (*Elaeis guineensis*), Rattan Palm (*Calamus spp.*), Bismark Palm (*Bismarckia nobilis*), Fan Palm (*Livistona spp.*), Betel Nut Palm (*Areca catechu*), Foxtail Palm (*Wodyetia bifurcata*), Traveler's Palm (*Ravenala madagascariensis*)
2	Ginger Collection	Ginger family (Zingiberaceae), which is known for its aromatic rhizomes and beautiful flowers - Zingiber, Alpinia, Curcuma, Etlingera and Hedychium
3	Bambusetum	Bambusa, Dendrocalamus, Gigantochloa, and Phyllostachys.
4	Etnoflora Collection	Used for various purposes, including medicinal, culinary, ceremonial, etc Tongkat Ali (*Eurycoma longifolia*), Kacip Fatimah (*Labisia pumila*), Pandan (*Pandanus amaryllifolius*), Betel Leaf (*Piper betle*), Lemongrass (*Cymbopogon citratus*), Ginger (*Zingiber officinale*) and Bamboo (various species)
5	Herbs Garden	Medicinal Herbs: Misai Kucing (*Orthosiphon stamineus*), and Kacip Fatimah (*Labisia pumila*) etc; Culinary Herbs: Pandan (*Pandanus amaryllifolius*), Turmeric (*Curcuma longa*) etc.; Aromatic Herbs: Lavender (*Lavandula spp.*), Mint (*Mentha spp.*), Basil (*Ocimum basilicum*) etc
6	Climbers	Ornamental shrubs etc. Bauhinia (*Bauhinia spp*), Bougainvillea (*Bougainvillea spp*), Jasmine (*Jasminum spp*.), Passionflower (*Passiflora spp*), Climbing Fern (*Lygodium spp*.), Pepper Vine (*Piper nigrum*), Thunbergia (*Thunbergia spp*), Ivy (*Hedera spp*), Hoya (*Hoya spp*)
7	Fruit Trees Collection	Native fruits tree etc Durian (*Durio spp*), Mangosteen (*Garcinia mangostana*, Rambutan (*Nephelium lappaceum*), Longan (*Dimocarpus longan*), Jackfruit (*Artocarpus heterophyllus*), Papaya (*Carica papaya*),
8	Gymnosperm Collection	A group of seed-producing plants that include conifers, cycads, ginkgo, and gnetophytes.
9	Denai Razak	Dense forested shrubs, open spaces, and sections with water features such as streams and small ponds.
10	Lotus Pond	Aquatic plants etc such as water lilies (*Nymphaea spp*.), water hyacinth (Eichhornia crassipes), and various species of reeds and sedges.
11	Dipterocarp Collection	Tall canopy trees etc. *Shorea spp*., Dipterocarpus spp., and *Hopea spp*.

The theme parks have been designed to serve various functions based on the types of plantations they showcase, with each plant species playing a unique role within the park.

Fig.11: Eleven (11) theme park was developed in Kepong Botanical Garden

KBG has also embraced the opportunity to participate actively in conservation efforts. As depicted in Fig. 10, the facilities presented support the conservancy program. Under this program, trees and other plants are sourced from their natural habitat, transported to KBG, and nurtured in a controlled environment for public display and use in ex-situ restoration projects.

Fig.12: Nursery facilities to support plant growth, care, and propagation activities.

4.1.3 The challenge of Kepong Botanical Garden towards conservation of plant diversity

After observing the site, it was found that improvements are needed for the Kepong Botanical Garden (KBG) in responding towards the conservation of plant diversity. The first stage in starting a successful botanic garden is developing a detailed management and operating plan. KBG must catch up to the other botanical gardens regarding plant taxonomy research initiatives and the facilities, equipment, and approaches connected with herbaria. Specific conservation efforts and outcomes, such as seed or material exchanges with other botanic gardens, arboreta, or research organisations, should be evaluated at the organisational level.

However, despite achieving the aims, the importance and value of botanical gardens still need to be determined in Malaysia. Hence, due to this, the efficiency of a botanical garden as a conservation centre is still in doubt as this is partly because there is a lack of clear guidelines to serve as a reference for the development and execution of the botanical garden concept, resulting in uncertainty about their actual purpose. This is viewed as a challenge for Kepong Botanical Garden, mainly about conservation efforts. In addition, more understanding and knowledge of the concept of the botanical garden is needed. This assessment is supported by findings in Table 4, derived from a series of semi-structured interviews.

Following the discoveries attributed to the case study, an expert with a diverse background has provided insights into an overview of botanical gardens in Malaysia, Kepong Botanical Garden, and their importance in plant conservation.

Table 5: Interview results with experts (KBG, NLD & ILAM)

A. Experts who understand the botanical garden as a whole		
QUESTIONS		**FINDINGS**
1. For existing botanical garden in Malaysia, how can it be considered a botanical garden?	NLD 1	(BGCI) criteria: Plant species, research, conservation, teamwork as well as educational. KBG is lacking in completing those 4 components.
	ILAM 1	They may need to develop a guideline that this is a help to recognize a botanical garden; perhaps a specific number of species is required before calling it that.
2. What is the importance of having a botanical garden in a country?	ILAM 1	Allows to storage of data regarding plant species according to the families… …It allows a landscape architect to discover what types of tree species are ideally to be planted in the city...
B. Experts who understand the botanical garden as a whole		
QUESTIONS		**FINDINGS**
1. In your opinion, can KBG conserve all plant diversity?	KBG 1	Impossible due to owing to land and financial limits. Botanical gardens must prioritize which species and families must be preserved in their natural habitat.
2. What sort of program can be implemented to ensure that the objective n conserving plant diversity can be done efficiently?	KBG 1	This is based on species dependent; there is no one-size-fits-all approach. Botanical gardens will use a mix of treatments depending on the species.
	KBG 2	There is no guarantee that one strategy will work for all trees since each procedure is unique to each braid. KBG is unable to offer the best approach for all trees.
	KBG 3	Ex-situ is a normal operation in all botanical gardens for conservation. In-situ is a project initiated by the owner land itself that needs a long commitment from all agencies.
3. What are the challenges of KBG to sustainers' conservation centre of plant diversity?	KBG 3	Funding is unquestionably the biggest obstacle. To ensure the species' survival outside of its native habitat. Management & facilities

* KBG 1, KBG 2 and KBG 3 are the representatives from the Kepong Botanical Garden
* NLD 1 I is the representative of the National Landscape Department
* ILAM 1 is Institute of Landscape Architects Malaysia

The semi-structured interview with representatives from three experts, NLD, KBG, and ILAM, resulted in the discussion below, based on the sentiments from the interview and discussion.

Table 6: Interview results with experts (KBG, NLD & ILAM)

NO	QUESTION	SENTIMENT	SCORE
A. Experts who understand the botanical garden as a whole			
1	For existing botanical garden in Malaysia, how can it be considered a botanical garden?	negative	0.423604
2	What is the importance of having a botanical garden in a country?	positive	0.954892
B. Experts who understand the botanical garden as a whole			
1.	In your opinion does Kepong botanical garden can conserve all the plant's diversity?	negative	0.423604
2.	What types of programs could be implemented to ensure that the objective of conserving plant diversity can be done efficiently?	positive	0.635866
3.	What are the challenges of KBG to sustainers' conservation centre of plant diversity?	positive	0.98366

The table above shows that having positive sentiments can be relevant and beneficial for KBG. On the other hand, negative feelings might lead to overly specific actions that do not apply to Kepong Botanical Garden. KBG is actively involved in environmental protection, focusing on ex-situ conservation. However, this should be complemented with in-situ activities (Wyse et al., 2000). Furthermore, KBG must adhere to guidelines established by authorities and the Botanic Gardens Conservation International (BGCI) for effective plant biodiversity conservation. Although the garden has established plant collections and herbariums, it should prioritise botanical research to strengthen its role as a conservation steward. Collaboration with universities, flora revision, threat assessments, and conservation monitoring is crucial. Shifting priorities in resource allocation, funding, and public attention can help botanical gardens address the plant extinction crisis. Thus, enhancing the ability to scale up these efforts can increase impact and achieve cost-effective results for biodiversity conservation, as highlighted in the word frequency image below.

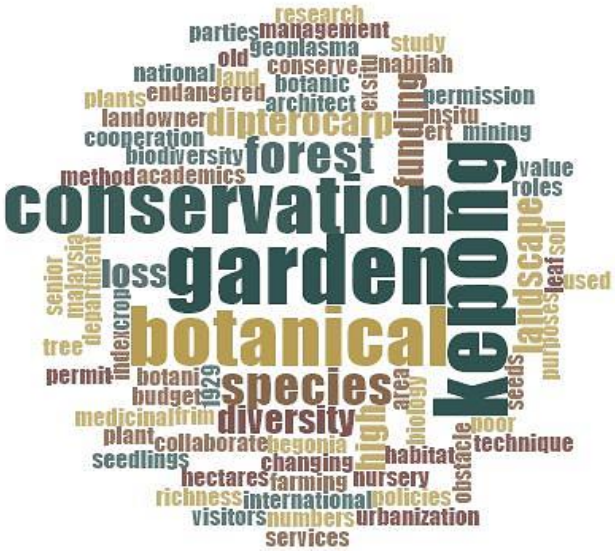

Fig.13: Word frequency from the interview

Consequently, it is important to enhance the concept of botanical gardens in Malaysia by promoting a better understanding, knowledge, and guidelines for their development in both the public and private sectors. Governmental and private organisations, as well as the public,

are increasingly recognising the importance of this concept. To facilitate the future establishment of botanical gardens in Malaysia, it is crucial to create well-defined guidelines that outline garden spaces' physical characteristics and layout.

5.0 CONCLUSION & RECOMMENDATION

To effectively position the Kepong Botanical Garden (KBG) as a leader in conservation and address the challenges mentioned, a strategic approach must be adopted as per the illustration generated from the findings above:

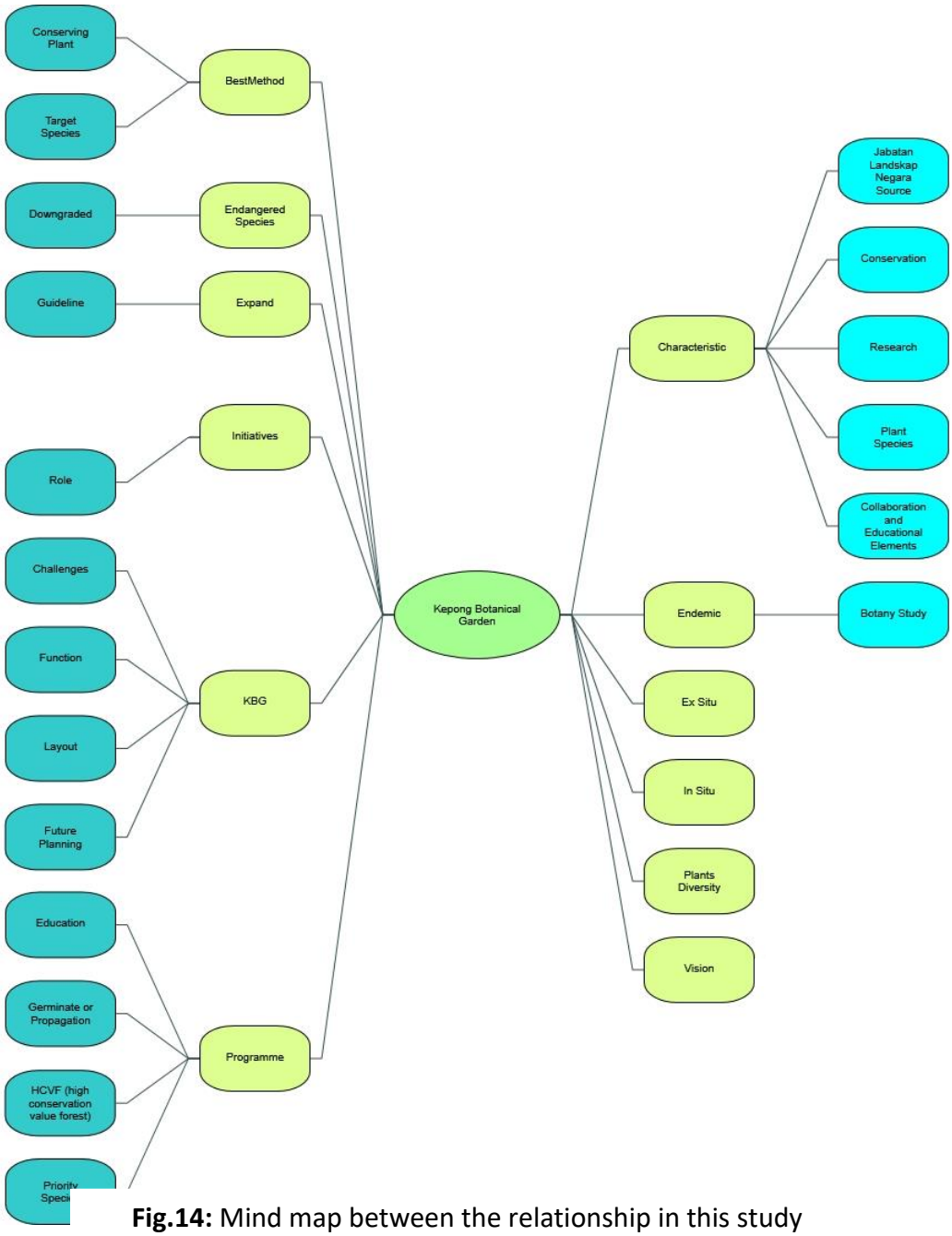

Fig.14: Mind map between the relationship in this study

This map outlines the theme of the primary purpose of Kepong Botanical Garden, the challenges it faces now, the types of methods and conservation programs implemented in the garden, and how space planning and management meet the need for botanical gardens.

Kepong Botanical Garden's conservation efforts help prevent biodiversity loss; however, this approach should align with guidelines set by the authorities and Botanic Gardens Conservation International (BGCI) while also addressing the garden's unique context and capabilities.

i. **Adhering to Conservation Guidelines and Policies**
KBG must strictly adhere to the guidelines and policies set out by BGCI and relevant Malaysian authorities. This involves adopting best practices in plant conservation, sustainable garden management, and public engagement.

ii. **Expanding Ex-Situ and In-Situ Conservation Efforts**
In addition to established ex-situ conservation endeavours, KBG needs to expand conservation efforts to include in-situ projects. This may involve forming partnerships with local communities and government bodies to conserve natural habitats and restore ecosystems.

iii. **Strengthening Research and Collaboration**
KBG should prioritise botanical research projects, focusing on taxonomy, ecology, conservation biology, and climate change impacts on plant species. Forming long-term partnerships with universities and expanding the herbarium and plant collection are crucial for research and conservation efforts.

iv. **Allocating Resources and Prioritizing Funding**
It is important to pursue diverse funding sources, including government grants, private donations, and international funding bodies, to support conservation initiatives. Increasing public engagement and awareness about plant conservation issues can also help attract support and resources.

v. **Long-Term Vision and Commitment**
Cultivating visionary leadership and integrating sustainability and resilience into garden operations are key to long-term conservation goals. This includes fostering innovation and continuous improvement within the organisation.

By following these steps, KBG can evolve into a leading botanical garden that preserves plant biodiversity and actively contributes to global conservation efforts. This approach will help KBG meet its potential as a conservation steward, ensuring the preservation of Malaysia's rich plant heritage for future generations.

ACKNOWLEDGMENTS

The authors would like to express their gratitude and appreciation to all who contributed to this study, directly or indirectly.

REFERENCES

BGCI Botanical Garden Conservation International. (2019). Retrieved from https://whc.unesco.org/en/tentativelists/6353/

Bennett, B. C. (2014). Learning in Paradise: The role of botanical gardens in university education. *Innovative Strategies for Teaching in the Plant Sciences*, 213-229.

Chen, G., & Sun, W. (2018). The role of botanical gardens in scientific research, conservation, and citizen science. *Plant Diversity*, 40(4), 181-188.

Dodd, J., & Jones, C. (2010). Towards a new social purpose: Redefining the role of botanic gardens. *University of Leicester*.

Espírito-Santo, D., Soares, A. L., & Veloso, M. (2020). Botanic gardens, people and plants for a sustainable world.

In *8th European Garden Congress, Lisbon, 2018.* ISAPress.
Gratzfeld, J. (Ed.). (2016). *From idea to realisation: BGCI's manual on planning, developing, and managing botanical gardens*. Richmond, UK: BGCI.
Havens, K., Kramer, A. T., & Guerrant Jr., E. O. (2014). Getting plant conservation right (or not): The case of the United States. *International Journal of Plant Sciences*, 175(1), 3–10.
Heywood, V. H. (2019). Recovering threatened plant species and their habitats: The need for integrated action. *Plant Diversity*, 41(2), 33–35.
Hengky, S. H., & Kikvidze, Z. (2018). Tourism sustainability in the Bogor Botanical Gardens, Indonesia. *Urban Forestry & Urban Greening*, pp. 30, 8–11.
Indonesian National Commission for UNESCO. (2018). Kebun Raya Bogor. Retrieved from https://whc.unesco.org/en/tentativelists/6353/
Lashley, J. (2012). Solving urban conservation issues through botanical garden functions.
Pimm, S. L., & Joppa, L. N. (2015). How many plant species are there, where are they, and at what rate are they going extinct? *Annals of the Missouri Botanical Garden*, 100(3), 170-176.
Pimm, S. L., & Raven, P. H. (2017). The fate of the world's plants. *Trends in Ecology & Evolution*, 32(5), 317-320.
Regan, H. M., Hierl, L. A., Franklin, J., Deutschman, D. H., Schmalbach, H. L., Winchell, C. S., & Johnson, B. S. (2008). Species prioritisation for monitoring and management in regional multiple species conservation plans. *Diversity and Distributions*, 14(3), 462-471.
Smith, P., & Harvey-Brown, Y. (2018). *BGCI technical review: Botanic gardens' economic, social and environmental impacts*.
Spencer, R., & Cross, R. (2017). The origins of botanic gardens and their relation to plant science, with special reference to horticultural botany and cultivated plant taxonomy. *Muelleria*, pp. 35, 43–93.
Tilman, D., & Lehman, C. (2001). Human-caused environmental change: Impacts on plant diversity and evolution. *Proceedings of the National Academy of Sciences*, 98(10), 5433-5440.
Wyse Jackson, P. S., & Sutherland, L. A. (2000). *International agenda for botanical gardens in conservation*. Botanical Gardens Conservation International.
Zainuddin, A. F., Mohammad, A., Hamzah, M. A., Moorthy, M., & Isa, M. Z. M. (2018). Koleksi pokok Taman Botani Kepong.

JOURNAL OF ARCHITECTURE, PLANNING & CONSTRUCTION MANAGEMENT
Volume 14 Issue 2, 2024 E-ISSN: 2462-2222 ISSN: 2231-9514

A GEOSPATIAL FRAMEWORK FOR SELF-SUSTAINING URBAN METABOLISM IN SOUTH TANJUNG DUREN AREA, WEST JAKARTA

Received: 14 June 2024 | Accepted: 07 December 2024 | Available Online: 07 December 2024
DOI: 10.31436/japcm.v14i2.887

Audrey Juliana[1*], Adli Nadia[2], Doni Fireza[3]

[1] Department of Architecture, Universitas Agung Podomoro, audrey.juliana@podomorouniversity.ac.id
[2] Department of Architecture, Universitas Agung Podomoro, adli.nadia@podomorouniversity.ac.id
[3] Department of Architecture, Universitas Agung Podomoro, doni.fireza@podomorouniversity.ac.id

**Corresponding author:*
Audrey Juliana
Corresponding author's email: audrey.juliana@podomorouniversity.ac.id

ABSTRACT

Urban metabolism plays a crucial role in shaping the sustainable development of regions since it relates to how resources are consumed, transformed, and disposed of dynamically. In an increasingly urbanized world, effective regional planning is essential to address challenges such as resource depletion, environmental degradation, and socio-economic issues. This study aims to create an implementation framework for urban metabolism in South Tanjung Duren, West Jakarta, selected as part of a larger urban metabolism model. The research introduces a practical approach for urban designers, architects, and local authorities to establish self-sustaining urban areas. The methodology consists of two stages. In the first stage, the study thoroughly assesses the object of the study. This includes profiling the essential aspects of the object study, environmental impact assessments, mapping material and energy flows, and categorizing groups to optimize urban metabolism. Findings from this stage shape the second stage, which uses urban infill strategies via four approaches: Collecting Resources, Creating Biotopes, Channeling Energy, and Catalyzing. These strategies are simulated on the study site to analyze flows of goods, people, waste, biota, energy, food, water, sand, clay, and air, creating a geospatial framework for self-sustaining urban metabolism. The findings underscore that South Tanjung Duren has strong potential for implementing an urban metabolism framework, with simulations revealing increased resource efficiency, effective waste reduction, improved green space, and minimized environmental impact. This framework not only enhances resource optimization and environmental protection but also fosters sustainable development, positioning South Tanjung Duren as a replicable model for resilient, self-sustaining urban neighborhoods.

Keywords: urban metabolism, urban infill, geospatial framework, self-sustaining

1.0 INTRODUCTION

Human populations have increased from two and a half billion in 1950 to seven points eight billion in 2020. It almost tripled with almost five billion people added up within eight decades (Kotkin, 2012) (Hesketh, Lu, & Xing, 2005) (Fischer, 2006). Even though several researchers predicted that the growth would slow down between 2020 and 2050, humankind has already faced global issues related to their needs in energy, food, waste and living qualities. In the realm of urban planning and architecture, one of the most significant implications is the ability to create a self-sustaining environment on a smaller scale of living ecosystems.

Changes from rural to urban are inevitable and would loosen the ability to have a self-sustaining environment. Slowly but surely, the rural areas which have always become a buffer zone to fulfil the urban needs will become more fragile and lose their ability to support their greater areas. Several aspects that are known as Land Use Intensification led to the development of land for commercial properties, transportation, and residential buildings, which can lead to deforestation, fragmentation, or other disruptions of much larger areas per household (Meyer, 2013). Along with it, poor air and water degradation quality are also increasing; biodiversity loss is also part of urbanization where land-use change, climate change, nitrogen deposition, and the introduction of invasive species, affect the ecosystems that animals and plants need; climate change is developed and eventually water scarcity happened.

Both the rate of ecosystem degradation and the cost of establishing engineered infrastructure are major drivers in determining the dearth of services in peri-urban areas. For example, when the cost of supplying the service is high for the environment, then nature could support only low population densities. Similarly, when the cost of building infrastructure is also high, then it is only economically viable at high population densities (Costanza, 2020). In such a situation, the green-loop system is likely to degrade before the red-loop system is fully established.

Thus, the idea of urban metabolism was introduced to help urban designers, architects, and local authorities to establish self-sustaining urban areas. With a global pandemic issue in mind, this framework would also provide a more practical implementation that solves an urban metabolism issue on a neighbourhood scale at the same time. In case another isolation ever happens again to a region, the population in a self-sustaining neighbourhood could still support their lives.

Since the earlier studies about urban metabolism have been focusing on a larger scale, an implementation framework using several architectural approaches such as urban infill development in one smaller urban fragment is challenging. This research introduces an innovative approach using urban metabolism to shape regional planning in the South Tanjung Duren area in West Jakarta through an experimental strategy. Although the geospatial framework proposed in this research is highly experimental, it surely could provide views on how people should act and how local authorities should start preparing a region to be resilient and self-sustaining.

By observation, Jakarta has almost everything to run the urban metabolism framework such as natural resources, biodiversity, demographic bonuses, landbanks owned by the government, and the awareness and eagerness of the society. In fact, the guidance in implementing this framework was still limited and needs to be studied further on a smaller scale in neighbourhoods and districts. This research conducted together with the students was not mainly talking about numbers and the impact of implementing the Urban Metabolism framework but rather discusses the built environment spatiality of the district that might be interfered with by the ideas themselves.

2.0 LITERATURE REVIEW

The Urban Metabolism idea was developed by Wolman in early 1965. It refers to the flow of materials and energy through urban systems, including the consumption of resources, the production of waste, and the impact of urbanization on the environment (Wolman, 1965). The first idea of urban metabolism was to understand the relationship between industrial

systems and the environment, which was initiated by Rapoport's ecological industries and Karl Marx's economic theory. Urban metabolism studies the flow of materials and energy through urban systems, including the consumption of resources, the production of waste, and the impact of urbanization on the environment (Lederer & Kral, 2015). The concept of urban metabolism has evolved over time, with researchers expanding its scope to include social and economic factors, and climate change's impact on urban systems (Céspedes Restrepo & Morales-Pinzón, 2018). Now, the urban metabolism framework has been used to inform urban planning and design, as well as to evaluate the sustainability of urban systems.

Urban metabolism was enhanced by Kennedy in 2007 by adding several indicators and measurement aspects such as carbon footprint calculations that subtracted from the flow of materials and energy through urban systems, including the consumption of resources, the production of waste and social and economic factors, as well as the impact of climate change on urban systems (Kennedy, Cuddihy, & Engel-Yan, 2007).

The principle of urban metabolism is a view of seeing a city as an organism, which has a metabolic process to live daily, which conceptually can be seen in Figure 1. When seeing as an organism, therefore it is important to see the big picture of the cycle of elements that are required in order to live. This may involve the quantifications of inputs, outputs, and storage of energy, water, nutrients, materials, and waste for an urban area. Thus, urban metabolism may be understood as a technical and socio-economic process that occurs in one city, causing many growths, energy production, and waste disposal. It plays a crucial role in shaping the sustainable development of regions since it relates to how resources are consumed, transformed, and disposed of dynamically (Stewart, Kennedy, & Facchini, n.d.; Wolman, 1965). As the world becomes increasingly urbanized, effective regional planning becomes important to address challenges, such as resource depletion, environmental degradation, and socio-economic issues.

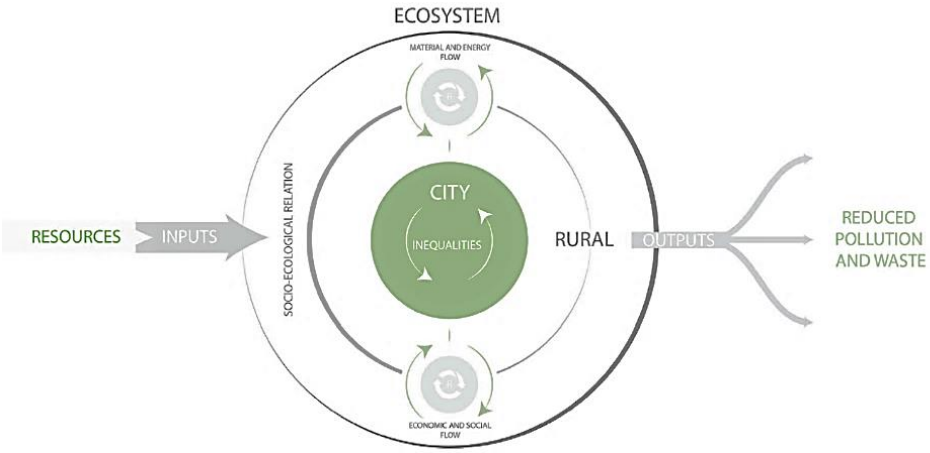

Fig. 1: Concept of Urban Metabolism (Lucertini & Musco, 2020)

As an organism, then another importance other than things that are related to economic-impact movements lies in understanding the socio-ecological relationships within an urban area. However, the process of looking at this needs to go through the metaphor that a city is an ecosystem, where urban elements interact with each other, both biotic and abiotic, and humans as inhabitants are equal components. All of them play a role in the flow of materials and energy (Grove, Cadenasso, Pickett, & Machlis, 2015).

Implementing urban metabolism study in urban planning would contribute to sustainable urban development since it promotes the city to optimize resource efficiency, waste reduction and recycling, improve environmental quality, enhance urban resilience, and gain better-informed decision-making, which supports the sustainable development goals to create the social and economic benefit for the city.

The study of urban metabolism now is more considered an interdisciplinary study, different from the earliest study of it that dominated as accounting exercises. This may be caused by the aspects of the city process varying, not to mention the political and historical aspects that affect the decision-making process in governing the city (Stewart et al., n.d.). Regardless of the complexity, there is a key connection between urban metabolism and the sustainable development of cities that needs to be found contextually and designed uniquely to simplify the implementation on a smaller scale. This approach was suggested because most of the cities that need to be self-sustaining have experienced stagnant development, with a high density of population, and complex demography and socio-economic situation. Any progressive or intimidating development might lead to community rejection and result in failure.

However, there are also challenges to studying urban metabolism, such as the lack of data on resource flows in many cities. It is important to continue to research and develop this concept to create more liveable and resilient cities for the future. This challenge brings up the urban metabolism into a utopian framework that is hard to apply in existing conditions that involve people on smaller scale regions.

3.0 METHODOLOGY

This study is divided into two stages, in which each stage has several steps to be done. The first stage is more towards an academic process, which is applied to the case study as an object selected with the consideration of its bigger context as the background of the study. The second stage is an experimental stage to apply the urban metabolism framework using the result of the first stage. As the South Tanjung Duren area is a small fragment in West Jakarta municipality, then Jakarta can be considered as a background of the study.

3.1 First stage: Complete assessment the Object

The first stage consists of several steps implemented in the object of study to gain subjective aspects as variables for the second stage. They are:

3.2 Profiling the object

Looking for implementation possibilities of urban metabolism framework in Jakarta requires geospatial information of the region itself. Jakarta is the capital and largest city of Indonesia, located on the northwest coast of Java. The city has a long and rich history, with evidence of human habitation dating back to the fourth or fifth centuries.
The government has implemented various strategies to make Jakarta self-sustaining, including the 2014 smart city concept, the sustainable urban development framework during Governor Fauzi Bowo's tenure, community-driven incrementalism under Governor Anies Baswedan, and the 2020 urban environmental management system. These initiatives aimed to improve environmental quality by tackling issues such as poverty, pollution, and flooding

but have not effectively enhanced the city's material, resource, energy, and waste management.

Despite these efforts, Jakarta has yet to adopt an urban metabolism framework, which could be more appropriate given the growing public awareness. South Tanjung Duren area is identified as an ideal pilot location due to its complexity and availability of resources, materials, energy, food, and waste management infrastructure, as indicated by remote sensing data. This area features Kampong Kota, commercial zones, diverse housing, rivers, government land, and an engaged community that actively supports cleanliness and waste management programs.

A vital aspect of urban metabolism is the urban food system, essential for achieving self-sufficiency. Analyzed GIS data shown in Figure 2 reveals that 80% of South Tanjung Duren consists of residential areas, including houses and apartments, predominantly on the eastern side. In 2019, the total population was 32,839 (15,847 males and 16,992 females) (Kantor Walikota Jakarta Barat, n.d.)., resulting in high food demand. Thus, ensuring food security and developing a self-sustaining regional plan is crucial for this community.

Fig. 2: Zoning of South Tanjung Duren, West Jakarta

South Tanjung Duren has various untapped local resources, while the community continues to rely on external sources. However, these resources hold significant potential for local processing to bolster the urban food system. Initiating an urban metabolism process within the region could foster self-sustaining regional planning. To achieve greater sustainability, the prevalent linear metabolism model common in most cities must transition to a circular metabolism approach. Although the scale of metabolism may differ, integrating circular systems across urban regions can enhance a city's overall sustainability.

This research will experiment with strategic regional planning that incorporates circular metabolism principles such as resource collection, biotope creation, energy channelling, and system catalysis. By applying these strategies, the study aims to simulate a self-sustaining regional plan that ultimately supports the development of a circular economy in South Tanjung Duren.

3.3 Environmental Assessment

This step uses the environmental assessment method by Rapoport. They consist of sustainability aspect (Ness, Urbel-Piirsalu, Anderberg, & Olsson, 2007), interregional exchange (Blanc & Friot, 2010) (Kissinger & Rees, 2010), territorial impacts (Loiseau, Junqua, Roux, & Bellon-Maurel, 2012), and urban metabolism (Sun et al., 2016) (Zhang, Yang, & Yu, 2015). The purpose of this environmental assessment is to identify the critical issues that may be impacted by the proposed project or development. This involves scoping, defining environmental impact statements, assessing the historical aspects, identifying the stakeholders involved, predicting the impact using magnitude, reversibility or irreversibility, duration, and zone, and proposing an environmental management plan that also talks about mitigation. Defining impact statements and predicting the potential impacts also involve air quality, water quality, soil quality, wildlife, and other environmental factors that would interfere with the urban metabolism framework.

Since the spatiality of the built environment and neighbourhood become the emphasis of this research, assessing the historical aspects and rethinking the context should implement several guidelines from the urban infills framework. Urban infill strategies aim to increase housing availability while minimizing city boundary expansion. This approach is considered a smart growth strategy to address the lack of space in densely populated areas and curb uncontrolled urban expansion. Urban infill involves developing vacant or underutilized land within existing urban spaces, enabling cities to expand housing without extending their boundaries. Additionally, urban infill contributes to neighbourhood revitalization and helps mitigate urban sprawl (Jones & Williamson, n.d.) (Talen, 2015).

Key strategies for urban infill development include adaptive reuse (Al Shamarti & Al Shammari, 2020), mixed-use development, transit-oriented development, small-scale projects, and green space preservation (Abedini & Khalili, 2019). However, challenges such as limited land availability, zoning regulations, community resistance, and higher costs must be considered. In high-density cities, available land for infill development is often scarce, making large-scale implementation difficult. Zoning regulations can further hinder urban infill by limiting the types of development permitted on potential sites.

Despite these challenges, integrating urban infill development into the study area remains a viable approach. The process is intricate and may face community resistance due to concerns over increased density, traffic, and noise. Additionally, urban infill development can be costlier than building on greenfield sites because of the need for extensive site preparation and infrastructure enhancements (Jones & Williamson, n.d.). Understanding these complexities is essential for effective planning and execution of urban infill projects.

3.4 Resources and materials mapping

To implement the urban metabolism framework that has a good flow of material, resources, energy and waste, the processing facilities should be accepted by the context first. The initial step to be conducted is mapping the resource, material and possible place to be injected. Resources and materials were divided into natural resources and waste. It is not only the types of resources and material, but also the zones and amount they had. The possible place to put the processing facilities should be using the existing government buildings, public facilities, and land banks owned by local authorities.

Each place was measured using the key factors of urban infill developments such as Community Acceptance and Engagement, Density and Scale Appropriateness, Socio-Economic and Environmental Impact, Design Quality and Built Environment Integration. The community resistance can be viewed from the impact aspects. The bigger impact they have, the bigger possibilities would be accepted. The impact itself should not only be related to socio-economic, but also the built environment qualities that can widely use by the whole communities (Papangelou, Bahers, & Aissani, 2023).

3.5 Categorization and grouping

The next step that is needed after resource, material and place mapping, is creating a categorization and grouping. This categorization can help the urban metabolism flow goes more effective and efficient. The proposed type is: (1) good position or zones, easy infill strategies, high impact to communities; (2) Good position or zones, easy infill strategies, low impact to communities; (3) Good position or zones, complex infill strategies, low impact to communities; (4) Bad position, complex infill strategies, low impact to communities.

This step will also provide information how good the metabolism within an area can be achieved. If the first categories dominate the possible places, it can be more ideal to the metabolism itself. But otherwise, if the fourth category dominate the places, the metabolism can also be achieved but not in ideal conditions.

3.6 Second stage: Simulation of the Urban metabolism in the object

This stage is the action that implements the urban metabolism framework in the object, using results from the previous assessment. Urban metabolism is a combination of morphological and physiological that can be used in the prolonged process of reconstructing the city. (Oswald, 2003) This research introduces an innovative approach using an urban infill strategy to shape an urban metabolism in the South Tanjung Duren neighbourhood through four strategies, such as Collecting Resources, Creating Biotopes, Channeling Energy and Catalyzing. These different strategies are simulated by analyzing the flow of urban metabolism elements, which are goods, people, waste, biota, energy, food, fresh water, sand and clay, and air.

In the concept of urban metabolism, what becomes an issue is the boundaries of that urban area because the flows occur within the city's spaces. Therefore, it is important to define the physical boundaries and urban spaces before assessing and analyzing the various flows. As a base thought, a remote sense of how the South Tanjung Duren area is divided into commercial zones, housing and dwelling zones, public facilities zones and educational zones is presented. Figure 3 below shows the profile of the South Tanjung Duren area as an object of study.

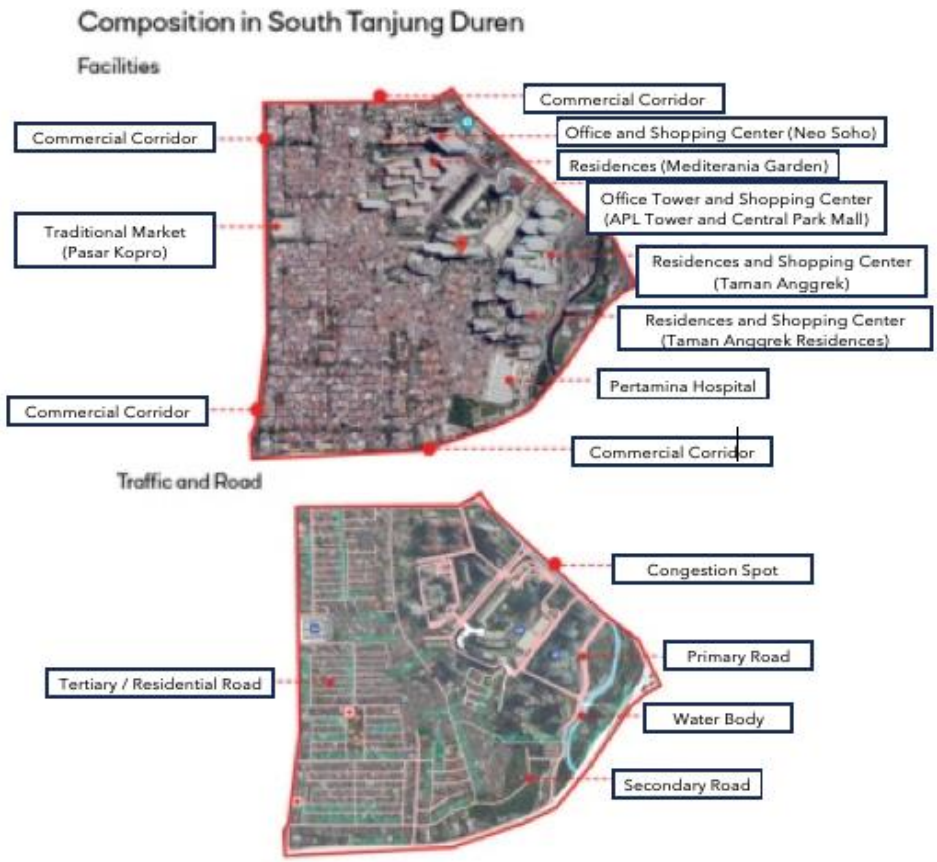

Fig. 3: Physical Boundaries of South Tanjung Duren

The first strategy is collecting resources in South Tanjung Duren by extracting raw materials from waste and food, such as plastics, cans, maggots and organic waste. Then, the second strategy is creating biotopes by improving existing urban nature including waterway aqueducts, hydroponics, catfish farms and carbon dioxide. The third strategy is channelling energy by using dry steam power plants, solar panels, and biogas energy. Lastly, the fourth strategy is catalyzing all earlier strategies into suppliers, food courts, laboratories and distribution centres, which will contribute to the collecting resources strategy again showing a circular metabolism system. These strategies simulate a unique network that shows various resource flows creating complex interdependencies and environmental impacts of various urban activities in the South Tanjung Duren area of the neighbourhood, which is accommodated by implementing the urban infill strategies as shown in the conceptual framework in Figure 4.

Various strategies could contribute to an urban metabolism that has more positive effects on the quality of life. These strategies will also improve the efficiency of their material flows while decreasing the negative effects on sustainability. This strategy is unique because it is based on local resources which will be simulated to a potential cycle to create a sustainable system.

Fig. 4: Conceptual framework of Urban Metabolism in Neighbourhood Scale

Re-using, redesigning, innovation and substitution are generally seen as being guiding principles for improving the sustainability of the use of materials in production and consumption chains. In this case, experimental simulation looks at the synergy between the various flows by linking them to each other at the regional level. Another strategy is to set up material flows in the production-consumption chains that are part of the urban metabolism. These chains cannot be seen separated from each other, but they could be perfected individually. Eventually, this strategy becomes a transition to a circular economy in the region.

4.0 ANALYSES AND RESULTS

These are strategies implemented in object of study as analyses of the simulation of the urban metabolism framework. Each strategy is analysed and gained the decision-making inputs of the urban spatial planning.

4.1 Collecting Resources

This first strategy, Collecting Resources, is how raw materials from waste and food in the region are obtained. South Tanjung Duren area produced a lot of plastic waste, organic waste, and recycled cans which have not been disposed of properly. Maggots are also found because of organic waste. These elements could be potential resources if developed well instead of throwing them away as waste.

South Tanjung Duren produces various types of waste, including household, organic (e.g., vegetables and fruits), and problematic plastic waste, accumulating up to 110 kg over two days (Muhammad Al Faruq Abdullah, 2021). Plastic waste, difficult to decompose, can be processed into polypropylene pellets for resale and durable by-products through a process of collection, sorting, chopping, melting at 650°C, cleansing, and drying, which conceptually is shown in Figure 5 below. This method yields compounds like Ethylene, Hydrogen, and Methane, which can fuel power plants after pyrolysis.

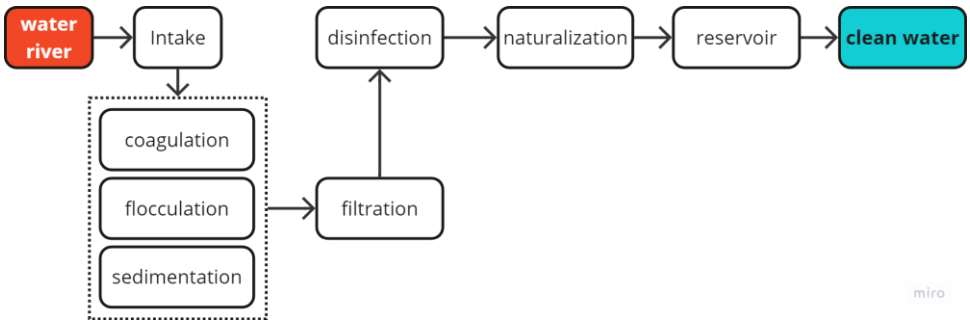

Fig. 5: Plastic Waste Subtraction Process

Additionally, recyclable inorganic waste such as cans, containing metals, can be melted and repurposed into new products. Due to the many residential areas and the Kopro Market, organic waste is also prevalent. Black Soldier Fly (BSF) larvae, derived from such waste, offer a promising maggot farming opportunity that could benefit South Tanjung Duren area economically and environmentally.

In simulating first strategy in this area, so, there should be some spaces that can be injected as facilities for resources and material collector. Looking to the object of study profile and the process of collecting resources, there are some criteria of places that can be categorized as suitable for these facilities, such as: the simplicity of implementing the infill development, less negative impact on community, good accessibility and achievability for the collector.

Fig. 6: Collecting Resources in South Tanjung Duren

By assessing the potential points and spaces for each resource and material collection from the spatial composition map of South Tanjung Duren area and using the variables of subject analysis gained from the first stage, the site of each facility to accommodate the first strategy can be decided.

Figure 6 above and Table 1 below is showing the location of spaces elected for facilities to be injected for collecting resources and material, and the surrounding context and typical proposed infill design.

Table 1. Designated spaces for location of resources and material collectors

No	Place	Existing and Propose Design	Argumentation
1	Kopro Market backyard. Suitable for waste and plastic recycle facilities	 	Good location and close to sources of waste. Simple strategies of infill development Good impact on communities
2	Public space near the river and The Empty space in between central park mall and Taman Anggrek Mall. Suitable for placing catfish farm	  	Good position Simple strategies of infill development Good impact on communities
3	Community Center. Suitable for placing maggots farm	 	Position is not close enough to the resources and material and it needs a small vehicular transportation to collect resources. Simple strategies of infill development Good impact on communities

4.2 Creating Biotopes

The second strategy, Creating Biotopes, focuses on enhancing urban nature using local resources like freshwater, sand, and clay. This involves developing waterway aqueducts, hydroponics, catfish farms, and carbon dioxide management. The principle behind this strategy is that harmonious coexistence with nature supports safe living and economic growth through food production. Maximizing urban nature would thus be highly beneficial. The approach requires simulating methods to produce food from local resources and biotopes.

South Tanjung Duren area is bypassed by a river, Grogol River. However, the water in this river is not clean. Thus, one of issues in South Tanjung Duren is the limitation of clean water. Clean water services in Jakarta have only reached about 20,000 liters per second out of 26,000 liters per second requirement(Arsito Hidayatullah, 2024). West Jakarta, where South Tanjung Duren is located, is one of the two regions in Jakarta which is still struggling with the clean water availability. Water security in West Jakarta has only reached 60,2%. (Bima Setiyadi, 2018) This condition needs to be improved by doing clean water treatment from the river so we can maximize the potential. Clean water treatment can be done using Reverse Osmosis, or simply using simple water treatment plant to gain preferred BOD and COD demands for the water to be able to be used for growing foods or planting freshwater fish. The scheme of simple water treatment plan and proposed design facilities by simulate the urban infill strategies can be seen in Figure 7 and Figure 8 below.

Fig. 7: Clean Water Treatment

Fig. 8: Water Purification

The Grogol River also had indigenous fish biota that could be found easily many years ago. However, with the clean water crisis in this area, this fish has not got a proper ecosystem. In fact, if this biotope condition is improved, it could be a potential resource. Fish farming could support good quality food and later has a strong impact in the local economy. Some endemic fish species that were found in West Jakarta rivers are Catfish, Uceng Fish, Beunteur Fish, Baung Fish, Bogo Fish and Julung Fish.

Another existing problem in South Tanjung Duren is traffic which causes a lot of carbon dioxide pollution. However, carbon dioxide actually could be processed into water by removing toxic compounds. This water function will be used as cool water to support a cooling tower.

South Tanjung Duren area could also have a potential in urban farming. Urban farming using hydroponic system can be applied by every household, or to any public facilities with certain management system by the community. This program could be inserted in the area to support quality of organic food and supply fresh products to the local Kopro Market. The scheme of relationship of this potential with other elements to create biotopes is shown in Figure 9. This shows that urban farming is also need the involvement of water supply, organic fertilizer, and local market in order to develop. Even so, the involvement of other party such as the scientific research is needed to maximize this strategy.

Fig. 9: Urban Farming Potential

The relationships among those mentioned elements are interdependent to create the biotopes within this object of study. The connection among those can be simulated in spatial planning shown in Figure 10 below.

Fig. 10: Creating Biotopes in South Tanjung Duren

4.3 Channeling Energy

The next strategy is Channeling Energy which means using by-products of energy extraction to get energy. In South Tanjung Duren, it is potential to make a channeling energy using solar panel and biogas energy.

Solar panel system is a potential in the Channeling Energy strategy. Placement of solar panel locations must be in a place that gets minimum of 80% light exposure before the sunset. Solar panel placement can be carried out in these four locations below. These locations are considered based on existing lighting simulations. Energy that comes out from solar panels in those specific locations will be allocated mainly for the public area such as street lighting and traffic light. The placement of solar panel installations in this area at least are on the public building such as local market, public school, and government office. The greenery area can also be placed by these installations since it will provide electricity for lighting and others in specific public spaces. The distribution of those is shown in Figure 11 below.

Fig. 11: Solar Panel Systems

The natural energy stated above will not be sufficient especially natural energy depletion is becoming another issue nowadays. Alternative energy is needed to support the sustainability of a sustainable urban metabolism. One of the alternative energy sources that has potential in South Tanjung Duren is biogas energy. Biogas energy is made from organic waste such as livestock manure, or kitchen waste like vegetables. These wastes will go through a decomposition process called anaerobic digester in an airtight room. The main components of biogas energy are methane gas (CH4) and carbon dioxide (CO2). Both gases can be burned or oxidized and release energy, which then could be used by humans for daily needs. In a day, the volume of waste produced in South Tanjung Duren area reached 11,120 kilograms of combined organic and inorganic wastes. Inorganic type waste collected reached around 110 kilograms (H. Ahmad Mujahid, 2022). These numbers are very potential to support us as an alternative energy source. Figure 12 is showing the scheme of biogas energy supply for community scale.

Fig. 12: Biogas Energy as Alternative Energy

The placement of these biogas energy installations should be planned to be able to distribute the energy resulted to the households in the area. Therefore, the location and the scale of the space to be infilled with these facilities should be sufficient and complementing each other with the source of energy. In this object of study are the organic waste and animal

waste. Table 2 below shows the argumentation of the location selected of biogas energy facilities.

Table 2. Location and argumentation of selected biogas facilities

No	Place	Argumentation
1	 Slums area near the river	Good position Simple strategies of infill development Bad impact on communities Scores: Medium
2	 Public space near the river	Good position Simple strategies of infill development Good impact on communities Scores: high
3	 Sports facilities	200 meters from the nearest river Simple strategies of infill development Bad impact on communities Scores: Medium
4	 Empty space in between Central Park Mall and Taman Anggrek Mall	Good position Simple strategies of infill development Good impact on communities Score: High

Therefore, channelling energy within this object of study by connecting these alternative sources of energy with other facilities from other strategies can be seen in this Figure 13.

Fig. 13: Channeling Energy in South Tanjung Duren

4.4 Catalyzing

The fourth step of the strategy is Catalyzing where the quality of flows of goods, people and air are boosted. This last strategy catalyzes all earlier strategies into suppliers, food courts, laboratories and distribution centers, which in the end will contribute to the collecting resources strategy again.

Food court as a public space is important to have in the catalyzing strategy because it allows goods contribution to the community. A food court would be a space to distribute the results of products which then could be consumed by the community.

Fertilizer Supplier would also be a helpful element in catalyzing strategy. The solution offered is a supplier shop that provides equipment for farming along with planting media, especially fertilizer. This shop could also be used for holding workshops on making compost from organic waste, which is expected to initiate an urban farming movement in the community.
South Tanjung Duren already has a local market, Kopro Market. This local market could be a perfect Hydroponic Laboratory and Distribution for Food Security. Smart hydroponic laboratory is also needed in this catalyzing strategy to expose the community to eco-technology and sustainability. This laboratory is needed to accommodate research about food resource quality.

The network of this strategy with other facilities resulted from other strategies can be simulate in the map of South Tanjung Duren area, shown in Figure 14 below.

Fig. 14: Catalyzing in South Tanjung Duren

5.0 DISCUSSIONS

The main goal of urban metabolism is to contribute in reducing the circulation of materials and resource consumption within cities. In the context of aiming for urban sustainability, what needs to be achieved is a balanced cycle between mass and energy. In this research, four strategies stated above are simulated in unusual ways to support each element to sustain the regional growth. Thus, these four strategies Collecting Resources, Channeling Energy, Creating Biotopes and Catalyzing, are interconnected to sustain the local condition in South Tanjung Duren as shown in the diagram in Figure 15 below.

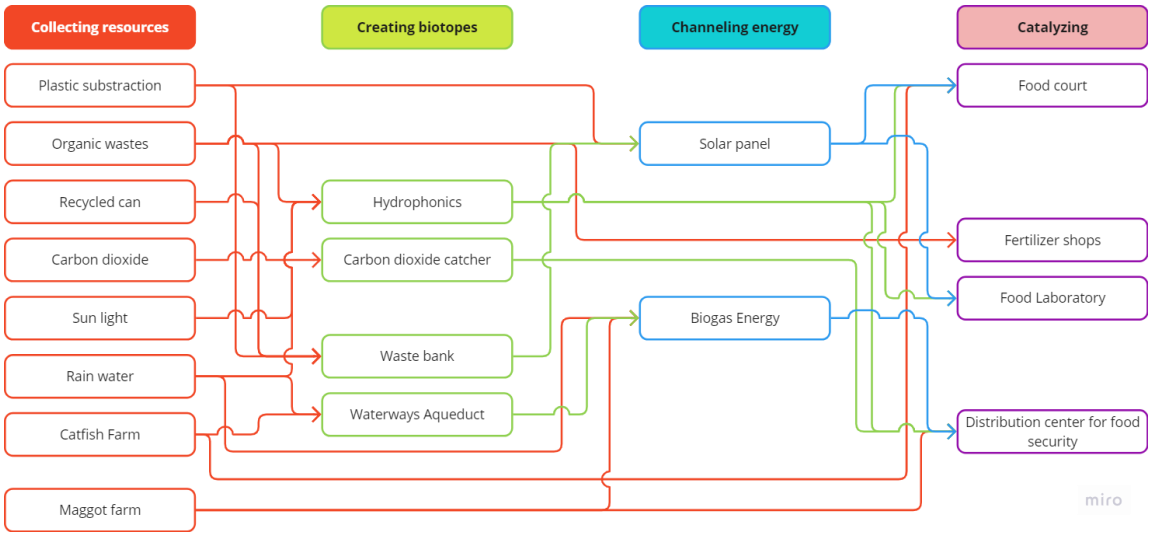

Fig. 15: Collecting Resources, Creating Biotopes, Channeling Energy, and Catalyzing Strategies

The implementation aspect has always been an issue regarding how complexes the existing context has become. Implementing this idea to a district as case studies might be able to help simulate the idea in Jakarta. One of the most important things is context understanding and data resources to correctly put the system in a neighbourhood. South Tanjung Duren area as the chosen sub-district has all the resources and it consists of residential, commercial, social and cultural facilities to accommodate and increase community involvement. Community involvement has become one of the important aspects to guarantee the system's sustainability since this idea needs several years before the impact can be quite useful to the community. Thus, as part of the implementing strategies, the build systems should avoid disturbing locals living qualities such as increased noise and smell pollution, alienated architectural forms, or other side effects that can reduce the community's sense of belonging. Collecting all the resource data in South Tanjung Duren is essential when simulating this framework. This sub-district has several natural resources that are needed, such as all-day sunlight in dry seasons and 121,3 mm3 rainfall in wet seasons, 1,3 km of riverbanks to cultivate protein, and 1,7 hectares of green area to cultivate fibre and vegetables. This district also has commercial resources such as 1,8 million square meters of commercial area and housing resources such as 2,3 million square meters of vertical housing, and 115,5-kilometer squares of landed houses (Kantor Walikota Jakarta Barat, n.d.).

Dry seasons supply adequate sun and heat energy that is potential enough to be captured by solar panels. Wet seasons supply enough water to be conserved and can be used to minimize the use of groundwater anthesis well during dry seasons. Housing supplies almost 12 tons of organic waste each week, nearly 4 tons of plastic waste each week and almost 2 tons of steel waste each year. The commercial area consumes almost 133 tons of vegetation and protein each week and the whole area needs almost 8 tons of steel for building renovation each month(Kantor Walikota Jakarta Barat, n.d.).

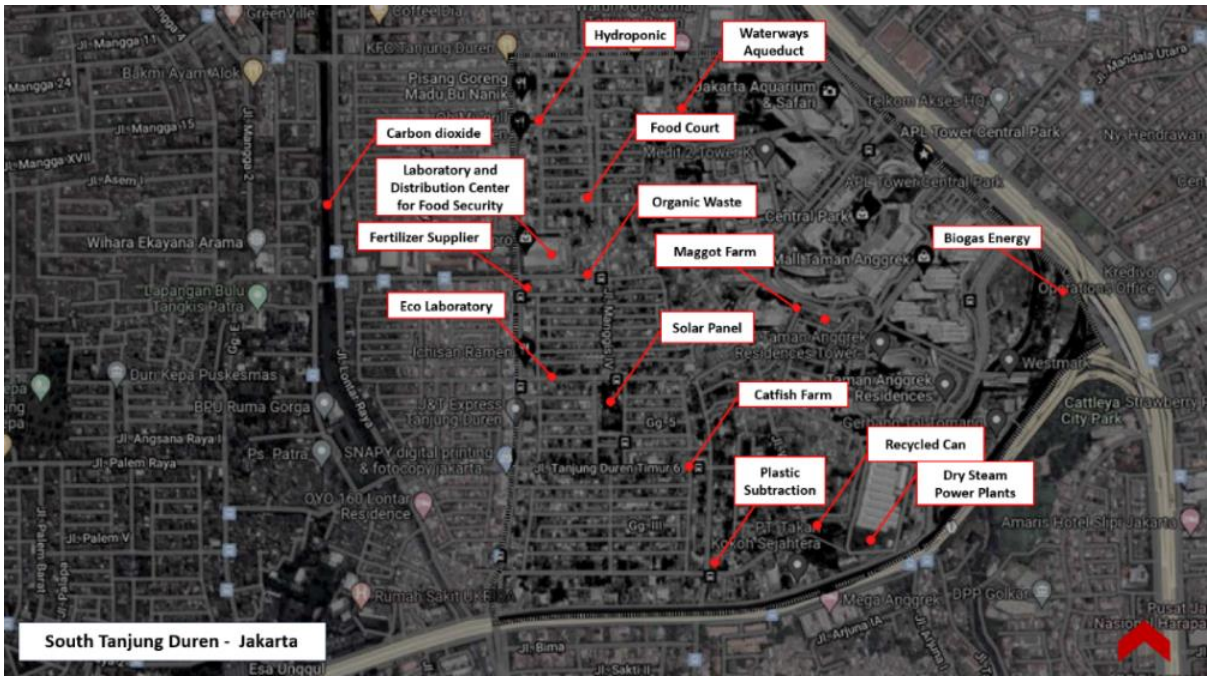

Fig. 16: Collecting Resources in South Tanjung Duren

Mapping the resources and mapping the processing plants in South Tanjung Duren are the crucial steps. Since this area has grown maturely, several social and economic segregations affect the resource and processing plant mapping. For example, even though the area has plenty of organic waste, plastic waste and steel waste, the processing plants cannot be implemented near the area because it consists of high-end communities that are quite sensitive to smell and noise. Another example that should be put in mind is the road width (ROW) that is unable to be expanded even more. Building the catalyzing facilities can increase the mobilization of people and might worsen the traffic jams.

Overall, this district can be separated into 6 zones such as commercial zones in Jl. Tanjung Duren Raya, river front zones in Jl. Tanjung Duren Barat and Jl. S. Parman, small housing zones behind Kopro Market and the south side of South Tanjung Duren, Real estate zones throughout Jl. Way Seputih. Podomoro City zones on the east side of the district, Taman Anggrek zones on the southeast side of the district, school, public library and sports zones west side of the district.

Injecting the processing plants, energy plants and catalyzers into the neighbourhood is done by choosing the building owned by the government that can be renovated using the adaptive reuse strategies. Adding a new building storey, infilling a new infrastructure on the existing yard, reprogramming the building function, and integrating the facilities into other zones of resources, are the strategies that can be implemented. Therefore, detailed building structures and their contextual settings are required to ensure the metabolism works properly.

Several government buildings that can be injected by collecting resources programs are district offices, postal offices, markets and sports facilities. These facilities were selected because their role in communities is quite important and able to gather people. The biotope plants will be placed near the public library and public school as part of their educational program to involve youngsters at an early stage. Channelling energy plants should be placed near organic waste collecting resources but should have a 50-meter distance to avoid smell and explosion possibilities. The catalysator facilities should be placed near the market, health facilities, school, RPTRA (community centre), Masjid or Church, so it can increase the commercial aspect and produce revenue to enhance the metabolism.

Other than those resources, more protein alternatives to replace the consumption of chicken and red meat are introduced. One of the protein alternatives chosen is maggot farming. Maggots were widely used in several tropical countries since it has shorter harvesting times and can be stored for longer periods by further processing. These maggots also supply the food to several endemic fish in Grogol River so the native ecosystems can be restored and able to cultivate fish as protein addition in the future. This maggot farm is best located in several RPTRA near the neighbourhood area.

Adding Carbon dioxide harvesting is needed to help filter the air in South Tanjung Duren since this sub-district has been affected by polluting industries found in greater Jakarta. Carbon dioxide processing will potentially supply several chemicals needed by various industries such as polymers, carbon fibres, and synthetic fuels and even more, it can feed up algae as alternative sources of fibre food. However, these processing plants have different criteria to put down. Calculating the wind flows to make sure that these processing plants can absorb

optimum CO2 is needed in the early stage. Since it produces a lot of noise, these harvesting plants should be put a bit further from the residential zones but near the closest source of CO2 such as a highway and beside a river to cultivate algae.

Besides solar panels as energy generators in dry seasons, this district will be equipped with dry-steam power plants that use heat produced by plastic and other waste coming from other sources. The heat produced by those plants is transferred using a copper line protected by heat insulators from several zones and compiled to generate enough heat to heat the water and produce steam. The electricity would then be stored in several batteries that could be used in social housing that needs support.

The most important things in this metabolism system are catalyzing facilities because they can affect the economic aspects of South Tanjung Duren communities. They should involve the communities at their heart to increase their sense of belonging. Therefore, the catalyzing programs not only sell the products that South Tanjung Duren produces such as food court and fertilizer supplies, but also laboratories and food security centers. This food security centre was designed to fulfil the entire year for half a million population in South Tanjung Duren with a five-year renewal cycle. It means, that if there are scarcity of several raw materials supplied by another region of Indonesia, South Tanjung Duren inhabitants should not be worried about the volatility price that might happen.

Fig. 17: Urban Metabolism Framework in South Tanjung Duren

The best place to put this food security centre is near the Kopro traditional market since these facilities need a huge number of freezers and chillers to contain foods and should be connected directly to three power plants to ensure 24/7 electricity.

The laboratories themselves take roles in enhancing multivitamins and minerals in plantations and fish. Their main task is enhancing the fertilizer qualities and creating optimum nourishment for fish farming. Since the raw materials to create fertilizer and pellets are quite excessive, these products can also become commodities to trade to other districts. Therefore, these facilities should be put in several places that have good accessibility such as Jl. South Tanjung Duren as main road.

6.0 CONCLUSION

From the simulation done in the South Tanjung Duren area, it is found that an established neighbourhood such as this sub-district can contain the potential resources that can be developed to create a self-sustaining area. The exploration of urban fabrics in the research objects within the perspective of urban metabolism may open up the possibilities for the implementation of this framework innovatively, especially using the strategy of urban infill. The involvement of all communities in the neighbourhood is essential since this approach to the neighbourhood scale is dependent on it when every part of the community is in an interdependent position. This simulation also found out that the involvement of local government in conditioning the city regulation is needed to promote the urban infill strategy to accommodate the facilities required.

Seeing that, there is no doubt that there is very potential to have an innovative approach using an urban infill strategy to shape an urban metabolism framework on a neighbourhood scale through four strategies, such as Collecting Resources, Creating Biotopes, Channelling Energy and Catalysing as proposed by Tillie et al. (2014). This research could inspire other regions too by extracting contextual resources in each region which eventually could help the city to be resilient and self-sustaining.

Accuracy in data collection has been a major challenge in this research since it is needed to implement and inject a massive new facility in an existing neighbourhood. An experimental strategy such as adaptive reuse needs flexibility for it to be implementable and it could be quite challenging to implement in another region with a lack of government facilities or in a region with hyper densities. This flexibility may require the local government policy to be more adaptive with the long-term self-sufficient objectives so the neighbourhood may be more ready to face challenges such as isolation from the pandemic.

This flexibility, however, would be important to pursue an effective and successful circular economy, which plays an important role in circular urban metabolism. Circular urban metabolism creates a framework for redesigning urban spaces, rethinking urban activities, as well as social infrastructures, including reducing, reusing and recovery of the available resources, which is something important that could be discussed in the future studies aiming for global sustainability through proper urban planning.

ACKNOWLEDGMENTS

The research acknowledges the contributions of the Architecture Design Studio 7 students from the academic year 2022/2023 at Universitas Agung Podomoro Jakarta. The students who participated in this study include Bryan Kemilau Liusono, Vicky Alward Hie, Viandro David, Jervis Kwang Gasono, Eldonia Irfon Jonatan, Veronica Riajelita, Jansen Luki Hadady, Davita Vania Puteri, Darwin Tunggala, Anwen Lo, Iong Hong, Marcello Rios, Joya Yohana, Moses Cristal Yamamichi, and Rizqi Puspita Pramesti. Their involvement was instrumental in the progress and completion of this research project.

REFERENCES

Abedini, A., & Khalili, A. (2019). Determining the capacity infill development in growing metropolitans: A case study of Urmia city. *Journal of Urban Management, 8*(2), 316–327. https://doi.org/10.1016/j.jum.2019.04.001

Al Shamarti, A. T., & Al Shammari, H. A. H. (2020). Urban infill as a tool to activate the quality of life in traditional cities. *IOP Conference Series: Materials Science and Engineering, 870*(1), 012010. https://doi.org/10.1088/1757-899X/870/1/012010

Arsito, H. (2024, April 26). Water access for Jakarta residents is not as simple as opening the tap.

Bima, S. (2018, December 4). Air bersih mulai terbatas di wilayah Jakarta Barat dan Jakarta Utara.

Blanc, I., & Friot, D. (2010). Evaluation of environmental accounting methodologies for the assessment of global environmental impacts of traded goods and services.

Céspedes Restrepo, J. D., & Morales-Pinzón, T. (2018). Urban metabolism and sustainability: Precedents, genesis, and research perspectives. *Resources, Conservation and Recycling, 131*, 216–224. https://doi.org/10.1016/j.resconrec.2017.12.023

Costanza, R. (2020). Valuing natural capital and ecosystem services toward the goals of efficiency, fairness, and sustainability. *Ecosystem Services, 43*, Article 101096. https://doi.org/10.1016/j.ecoser.2020.101096

Fischer, C. S., & Hout, M. (2006). *Century of difference: How America changed in the last one hundred years*. Russell Sage Foundation.

Grove, J. M., Cadenasso, M. L., Pickett, S. T. A., & Machlis, G. E. (2015). *The Baltimore school of urban ecology: Space, scale, and time for the study of cities*. Yale University Press. https://doi.org/10.12987/yale/9780300101133.001.0001

Mujahid, H. A. (2022, June 22). PGJSS: Empat bank sampah di TDS kumpulkan 110 kg sampah anorganik.

Hesketh, T., Lu, L., & Xing, Z. W. (2005). The effect of China's one-child family policy after 25 years. *New England Journal of Medicine, 353*(11), 1171–1176. https://doi.org/10.1056/NEJMhpr051833

Jones, E. D., & Williamson, J. (n.d.). *Retrofitting suburbia*.

Kantor Walikota Jakarta Barat. (n.d.). Kelurahan Tanjung Duren Selatan.

Kennedy, C., Cuddihy, J., & Engel-Yan, J. (2007). The changing metabolism of cities. *Journal of Industrial Ecology, 11*(2), 43–59. https://doi.org/10.1162/jie.2007.1107

Kissinger, M., & Rees, W. E. (2010). An interregional ecological approach for modeling sustainability in a globalizing world: Reviewing existing approaches and emerging directions. *Ecological Modelling, 221*(21), 2615–2623. https://doi.org/10.1016/j.ecolmodel.2010.07.003

Kotkin, J., Schier, S. A., & Mazza, M. A. (2012). *The rise of post-familialism*.

Lederer, J., & Kral, U. (2015). Theodor Weyl: A pioneer of urban metabolism studies. *Journal of Industrial Ecology, 19*(5), 695–702. https://doi.org/10.1111/jiec.12320

Loiseau, E., Junqua, G., Roux, P., & Bellon-Maurel, V. (2012). Environmental assessment of a territory: An overview of existing tools and methods. *Journal of Environmental Management, 112*, 213–225. https://doi.org/10.1016/j.jenvman.2012.07.024

Lucertini, G., & Musco, F. (2020). Circular urban metabolism framework. *One Earth, 2*(2), 138–142. https://doi.org/10.1016/j.oneear.2020.02.004

Meyer, W. B. (2013). *Countering commonsense antiurbanism*. MIT Press. Retrieved from http://www.jstor.org/stable/j.ctt5vjq7j

Abdullah, M. A. F. (2021). Pengelolaan sampah menjadi barang bernilai ekonomi di lingkungan Kelurahan Tanjung Duren. *Jurnal Pengabdian Masyarakat (ANDHARA), 1*(2), 9–18. Retrieved from http://jurnal.undira.ac.id/index.php/jpmk/

Ness, B., Urbel-Piirsalu, E., Anderberg, S., & Olsson, L. (2007). Categorizing tools for sustainability assessment.

Ecological Economics, 60(3), 498–508. https://doi.org/10.1016/j.ecolecon.2006.07.023

Oswald, F., & Baccini, P. (2003). *Netzstadt: Designing the urban*. Birkhäuser.

Papangelou, A., Bahers, J., & Aissani, L. (2023). Drivers of urban metabolism: Toward a framework for urban transformations. *Journal of Industrial Ecology, 27*(5), 1389–1405. Retrieved from https://econpapers.repec.org/RePEc:bla:inecol:v:27:y:2023:i:5:p:1389-1405

Stewart, I., Kennedy, C., & Facchini, A. (n.d.). *Megacities: Comparative analysis of urban macrosystems*.

Sun, L., Dong, H., Geng, Y., Li, Z., Liu, Z., Fujita, T., ... & Fujii, M. (2016). Uncovering driving forces on urban metabolism: A case of Shenyang. *Journal of Cleaner Production, 114*, 171–179. https://doi.org/10.1016/j.jclepro.2015.05.053

Talen, E. (2015). *Addressing seventy years of failed urban form*. University of Georgia Press. Retrieved from http://www.jstor.org/stable/j.ctt183q43f

Wolman, A. (1965). The metabolism of cities. *Scientific American, 213*(3), 178–190. https://doi.org/10.1038/scientificamerican0965-178

Zhang, Y., Yang, Z., & Yu, X. (2015). Urban metabolism: A review of current knowledge and directions for future study. *Environmental Science & Technology, 49*(19), 11247–11263. https://doi.org/10.1021/acs.est.5b03060

JOURNAL OF ARCHITECTURE, PLANNING & CONSTRUCTION MANAGEMENT
Volume 14 Issue 2, 2024 E-ISSN: 2462-2222 ISSN: 2231-9514

A BIBLIOMETRIC REVIEW ANALYSIS ON ENVIRONMENTAL CONSERVATION IN ISLAMIC PERSPECTIVES: MAPPING TRENDS

Received: 16 July 2024 | Accepted: 2 August 2024 | Available Online: 7 December 2024
DOI: 10.31436/japcm.v14i2.910

Illyani Ibrahim[1*], M Zainora Asmawi[2], Azila Ahmad Sarkawi[3]

*[*1, 2, 3] Department of Urban and Regional Planning, Kulliyyah of Architecture and Environmental Design, International Islamic University Malaysia*

Corresponding author:* ***Illyani Ibrahim*
Corresponding author's email: illyani_i@iium.edu.my

ABSTRACT

An environmental crisis is critical as it hurts the ecological, physical, and spiritual aspects. An extensive ecological and spiritual is necessary to comprehend this issue. The purpose of this study is to review the plethora of studies on environmental conservation from an Islamic perspective. This study uses a bibliometric analysis using RStudio to analyse the current research stream and assess trends in this topic. A total of 451 publications were retrieved from the Scopus database to reveal the knowledge structure of the past, current and future trends by assessing the most influential past publication, determining the structure of the co-cited publications and evaluating trends for future studies, historical development, keyword, citation and co-citation, institutions, and country-wise analyses were performed. The study produced three ground-breaking research streams evaluated using bibliometric analyses: environment protection studies and sustainable development from an Islamic perspective, economics protection from an Islamic perspective and issues of environmental problems, socioeconomic and religion towards Islamic perspectives. The outcome would facilitate future scholars linking this topic to environmental conservation.

Keywords: Bibliometric analysis, Conservation, Islamic, Scopus

1.0 INTRODUCTION

Irresponsible resource management, exploitation, and a lack of conservation initiatives lead to environmental degradation. Environmental harm includes forest destruction, noise, and air and water pollution. Furthermore, climate change exacerbates problems associated with global warming, ocean acidification, sea level rise, drought, and storms that impact numerous countries worldwide. Thus, it is necessary to have balanced environmental planning and management based on the positive values that uphold good practices on the grounds. In this regard, the stewardship of Islamic teachings leads to the principles of peace and harmony between man and the environment. The Islamic idea of peaceful coexistence and religious harmony is that all people are united under one God. This makes it necessary for Muslims to build bridges of understanding and cooperation to create a social order environment (Mihlar et al., 2016; Abdelzaher, 2019).

Furthermore, the principle of Allah SWT is the owner of the universe, while human beings are merely trustees, which will help to imbue a sense of stewardship with accountability in environmental management (Al-Quran; Ta Ha:6). The natural world that exists between the sky and the earth is described in the passage, including the sun, heat, wind, clouds, and rain. "And what is under the soil" alludes to the materials that can be extracted and invested below the surface, whether geological, metallic, or natural. It also contains groundwater that can be

extracted and utilised for habitation and farming (Ibrahim Hazim, 1985). As trustees of the earth, humans are expected to use these resources wisely, considering the long-term impact on the environment and future generations. As such, in line with the teachings of Islam, humans are responsible to Allah, and as representative, steward or vicegerent (*Khalifah)* on the earth (Al-Quran; Al-An'am:165), they are entrusted to protect the environment (Ismail et al., 2014). Attention to ethical and religious values guarantees the protection of the environment (Emeri, 2017).

Islam is an all-encompassing religion that covers social, political, economic, cultural, and environmental facets of human existence (Abdelzaher, 2019). However, overuse by human activity can disrupt the natural equilibrium (Greenfield, 2020). It has been mentioned in the Qur'an that "Indeed, all things We created with predestination" (Al-Quran; Al-Qamar:49), which means that everything, whether big or small, stationary or moving, speaking or silent, everything is created by Allah with predestination (Bazina, 2023).

Bazina (2023) also explained the balance and due proportion in the environmental ecosystem. This is clear from the current environmental problems (Bazina, 2023), such as deforestation, especially regarding climate change and biodiversity. Humans are Earth's Caliphs, so humans must actively protect the environment (Abdelzaher, 2019; Bazina, 2023). Furthermore, Islam strongly emphasises adhering to ecological principles and implementing responsible development [Cite]. For instance, the concept of hima (Arabic: حمى), meaning "inviolate zone" or "private pasture", which normally refers to an area set aside for the conservation of natural capital, typically fields, wildlife and forests - contrasts ḥaram, which defines an area protected for more immediate human purposes (Muhammad et al., 2010; Abdelzaher, 2019). In modern society, Hima is known as the environmental protection that is essential to curb environmental degradation (Gari, 2006). "Hima" is defined by Gari (2006) as a restricted pasture where trees and grazing areas are temporarily or permanently shielded from indiscriminate harvesting. The community that owned the Hima reserves was expected to contribute to the area's conservation (Chaudhry, 2022). For instance, some organisations were in charge of conserving water, while others were in charge of keeping an eye on grazing and protecting land from exploiting natural resources (Llewellyn, 2003).

Environmental conservation is one of the important aspects of protecting and preserving the natural environment, including ecosystems, biodiversity, air, water and soil quality, for the benefit of present and future generations. Allah SWT said to the effect that "And We have certainly established you upon the earth and made for you therein ways of livelihood. Little are grateful" (Al-Quran; Al-'Araf:10). Preserving the environment is vital since it is everyone's urgent responsibility (Sayem, 2021). Unfortunately, rather than safeguarding the environment, human activity either directly or indirectly has harmed it. Modern science and technology have given much power to humans to exploit the natural world ruthlessly through excessive consumption, the use of natural resources without considering the impact, or unhealthy living habits in the community, such as not managing garbage and waste disposal. This misconduct (the abuse of entrusted power for profit gain) has been registered in the Qur'an when Allah SWT said, "Corruption has appeared throughout the land and sea by (reason of) what the hands of people have earned so He (i.e. Allah) may let them taste part of (the consequence of) what they have done that perhaps they will return (to righteousness)" (Al-Quran; Al-Rum:41). The examples of righteousness such as avoiding harmful act and striving for knowledge and wisdom.

Religion can help to create a relationship between humans and the natural world (Sayem, 2021). Islam's teachings include a way of life that can influence its followers' views on life in addition to rules and restrictions (Rohman & Ibrahim, 2022). The author also added that the way of looking at life explains to people what the universe and its surroundings imply, how nature and people are both perfect creations of Allah Ta'ala and how important nature is to human worship. Understanding environmental ethics from an Islamic perspective is crucial based on the Qur'ānic guidance. The Holy Qur'an sets out complete spiritual and more ecological guidelines for man ((Muhammad et al., (2010). For example, the practice of balance is mentioned in the Holy Qur'an, where Allah instructs not to disrupt the balance that exists in nature- "And the sky he has uplifted; and He hath set the measure. That ye exceed not the measure" (Al-Rahman, 55:7-8). In the Qur'ān, humans are described as vicegerent (*khalīfah*) of Allah on earth to play a responsible role (*amānah*) on His behalf. As intelligent and responsible beings, humans must take care of the earth on Allah's behalf and should not do anything that may threaten other creatures' existence (Sayem, 2021; Rohman & Ibrahim, 2022).

Focusing on environmental conservation from an Islamic perspective is rooted in the belief that human beings are the stewards (Khalifah) of the Earth, entrusted by Allah with the responsibility of maintaining its balance and protecting its resources for present and future generations. The main purpose of human creation is as the caliph and servant of Allah SWT. There is a special focus within the Quran on the environment and its protection. Humans are prohibited from harming the environment and are encouraged to clean up any pollution (Emari et al., 2017). From an environmental perspective, both social equilibrium and *Tawheed* should lead to socio-economic justice, meaning that each human should receive what they deserve from the natural world, as well as participate positively in maintaining a high quality of life for others (Naqvi 1981, 2003; Platonova, 2013). *Tawheed* is the spiritual part that manifests the spiritual inner connection between human beings and their surrounding environment. The new millennium and the modern ecological crisis have created a need for environmentally based religion and spirituality (Mihlar et al., 2016).

One term, (Eco-Islam) is created to explain the foundational principles of why humans should care about the environment (Abdelzahir et al., 2019). Ahmed (2012) recommended implementing environmental management accounting (EMA) at Islamic companies to ensure nature conservation and the prosperity of humans and all creatures. Environmental accounting is an essential tool for understanding the role of the natural environment in the economic ecosystem (Abdelzahir et al., 2019). It can provide data highlighting the contribution of natural resources to economic well-being and the costs imposed by pollution or resource degradation. Thus, the EMA practice relates to product pricing, budgeting and investment appraisal in environmental planning (Abdelzahir et al., 2019). Fakhruddin (2018) indicated that the Al Quran-based learning content of Islamic Religious Education (IRE) on environmental conservation covers the following topics: the role of humans as natural resource protectors, the sustainability of nature as a living system, the growth of responsibilities, respect, and a caring attitude toward nature; and the wisdom of using natural resources.

Expanding awareness of environmental education leads to the creation of groups of people who can take better actions in environmental conservation and protection (Mangunjaya, 2011; Mangunjaya & McKay, 2012). Therefore, environmental education, which is known as a process that allows individuals to explore environmental issues, engage in problem-solving works and take action to improve environmental quality, is a critical requirement (Abdelzahir, 2019). The United Nations Educational, Scientific and Cultural Organization (UNESCO) Environmental Education Conference 2007 emphasised the need for broader social and cultural studies, changes in educational thinking, and immediate maintenance of education institutions. The Education Sustainable Development (ESD) has been developed, and existing education programmes need to be re-aligned with the purpose of ESD (UNESCO, 2021). It emphasised the need for environmental education to address the harsh reality of unsustainable development and climate change. The conference aimed to create a global community concerned with the environment and committed to solving existing and future environmental problems.

Accordingly, this paper reviews the literature on environmental conservation from Islamic perspectives, identifies their thematic evolution, and then provides directions for future research within this problematic area. The bibliometric analysis method was applied to proceed with this review consistently. This paper's contribution matters because we need to understand the topic trends and its intellectual and conceptual structures and critically evaluate the current level of contribution.

We use VOSviewer and RStudio in the present study as visual and analytical research tools. The target articles were chosen by selecting titles that included 'environment or environmental', 'conservation or preservation or protection', and 'Islam or Islamic'. Several restrictions were set before the search. This study uses 451 papers, covering almost every important article in the field of research. The literature was downloaded in January 2024 from Scopus, one of the best academic databases.

The paper consists of five sections. The first section explains the introduction and concept of this paper. Section 2 describes the study's methodology and the sample construction of the review. Section 3 provides an in-depth discussion of the key results in the research streams derived from network and content analysis processes. Finally, Section 4 concludes the study and provides recommendations for future research.

2. METHODOLOGY

2.1 Bibliometric analysis

Bibliometric analysis is a quantitative approach that analyses published papers to evaluate academic publications in a specific field (Ding & Yang, 2020). Ellili (2023) states that bibliometric analysis depends on bibliographic materials highlighting a specific field's core theoretical and empirical research. Bibliometric analysis is useful for mapping the cumulative scientific knowledge of weak established fields by rigorously analysing a large volume of unstructured data (Donthu et al., 2021). A visual representation can reflect bibliographic units in the form of documents, words, journals and authors that serve as the mapping output (Donthu et al., 2021). The contribution of this study based on the method of incorporating bibliometric analysis to identify relevant and critical publications in environmental

conservation in Islamic perspectives (citation analysis; to provide the structural link and relationship between the most influential cited publications (co-citation analysis); and to evaluate emerging trends for future studies (co-occurrence of keywords analysis).

2.1.1 *Science mapping*

The techniques for science mapping include citation analysis, co-citation analysis, bibliographic coupling, co-word analysis and co-authorship analysis (Donthu, 2021).

2.1.2 *Citation analysis*

Citation analysis identifies the links between publications when one publication cites the other (Appio et al., 2014). The citation frequency indicates that such publication is significantly based on its high number of citations. Additionally, it communicates to the working researcher the noteworthy contributions to the field of research. In environmental conservation, this method would be an essential guide for scholars to follow while examining the major papers that might provide crucial insights into Islamic viewpoints on the conservation of the environment. Citation analysis offers important insights into the publications' relative importance. On the other hand, it falls short when assessing the networks of connections between the data (authors, publications, country, and journal). Co-citation analysis will be used to supplement this shortcoming.

2.1.3 *Co-citation analysis*

Co-citation analysis is a technique on the number of publications that are cited together frequently are similar thematically (Hjørland, 2013). The technique builds on similarity metrics between papers, journals, and authors using co-citation counts. Co-citation analysis allows researchers to identify theme clusters in addition to the most important publications. The listed papers serve as the basis for these theme groups. Co-citation analysis, on the other hand, focuses solely on highly cited articles, excluding recent or specialised publications from its topic clusters. Co-citation analysis is therefore appropriate for business academics looking to find foundational works and knowledge bases. According to van Eck and Waltman (2017), the co-citation counts and total link strength of prominent publications are used to calculate the overall strength of an author's co-authorship with other writers. Even though this method has been used in similar bibliometric research before, it is improved by combining it with citation analysis to determine the most important topics more accurately in Islamic literature and environmental conservation.

2.1.4 *Co-occurrence of keywords*

Co-occurrence of keywords or co-word analysis is a method for calculating the frequency of keywords occurring in the chosen publications is co-occurrence of keywords. The primary purpose is to investigate the keyword interaction that may point to the most prominent and significant issue during the research. It can also used to evaluate patterns and developments of research themes. Co-occurrence of keywords analysis looks at the relationships between ideas that appear more than once in the titles, keywords, and abstracts of texts. Integration of co-occurrence of keywords analysis and co-citation analysis offers a thorough assessment of a topic's structure and indicates the future course of research (Tan Luc et al., 2020).
This bibliometric study undertakes a systematic process that involves three stages.

1. Set the search process to;
   i) Identify the search in the Scopus platform by incorporating the relevant keywords into a logical search statement, including a Boolean function.
   ii) Introduce relevant inclusion and exclusion criteria to narrow down the scope of the literature.
   iii) Carry out bibliometric analysis (BPA) using RStudio and VOSviewer.

2.2 Data Collection

The data were obtained from the Scopus database. The data has been widely adopted in bibliometric analysis. Scopus is one of the largest curated abstract and citation databases with a broad global and regional coverage of scientific journals, conference proceedings, and books (Baas et al., 2020). In addition, an independent Content Selection and Advisory Board rigorously selects and re-evaluates content to ensure that only the highest quality data are indexed (Baas et al., 2020).

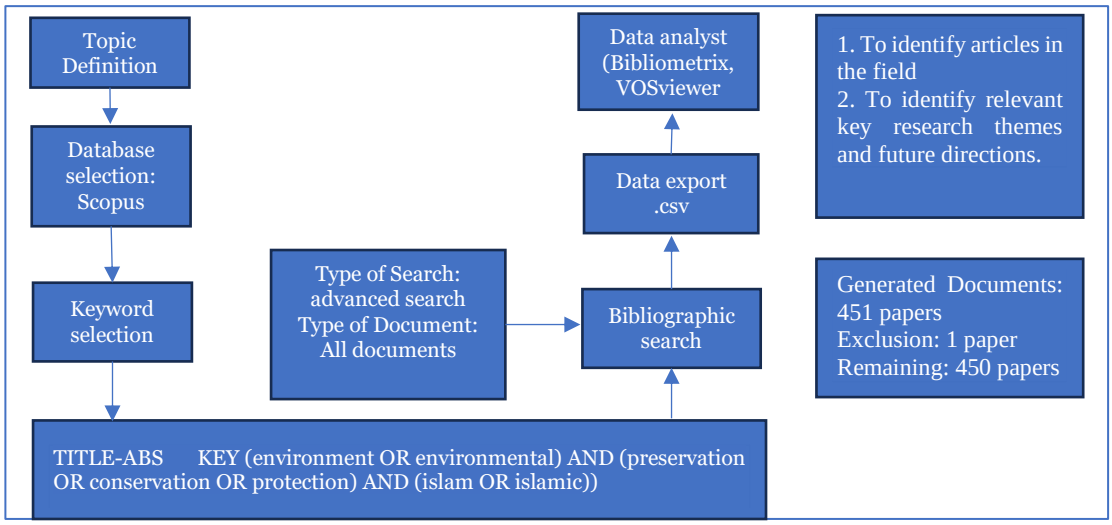

Figure 1: The methodology of the research

2.2.1 Search String

The following search string was used for this topic in the Scopus document search. All document types included journal publications, conference proceedings, books, book chapters, letters, and notes without applying any restrictions. The search was performed on 21st December 2023. The language is English. The process returned 451 publications ranging from 1980 to December 2023. The data were screened in stages, as shown in Table 1. After that, the data were exported to CSV format and uploaded to VOSviewer and Bibliometric RStudio.

Table 1: Search string used in the Scopus database.

Keyword using Scopus database	TITLE-ABS KEY (Environment OR environmental) AND (preservation OR conservation OR protection) AND (islam OR Islamic))

3.0 RESULT AND ANALYSIS

This section discusses the results using VOSviewer. First, we present the descriptive analysis and publication trends. Then, we present the top ten journal publications, the most productive and influential universities, the most productive and influential authors, and the most productive and influential countries. Secondly, we present network visualisations, co-citations of authors, co-authorships, and bibliographic coupling of authors, institutions, and countries.

3.1 Descriptive analysis and publication trends.

Table 2 provides information on articles retrieved from the Scopus published from 1959 to 2023. It was found that 451 papers were published in 64 years.

Table 2: Descriptive statistics from 1959 to 2023

Articles	451
Timespan	1959-2023
Authors	1066
Average citations per article	6.43
Single author documents	171
Co-author per document	2.48
International co-authorship %	14.44
Total journal	331
Authors per article	2.48
Author's keywords	1,864
Institutions	354
Countries	52

The descriptive analysis based on the data obtained can be seen in Figure 1. From the 451 publications, the highest citation was 73. The earliest publications were published in 1959. However, the frequency of production slowly increased until 2005. The topic received and upsurged in interest until the recent one. The highest number of articles were published in 2023. More studies are expected to be produced as environmental conservation from an Islamic perspective is highly anticipated. Furthermore, the emergence of several key streams in the field interests scholars and practitioners. The annual scientific production fluctuates throughout time, and the highest citation was in 2012.

The progression of papers published related to environmental conservation from 1959 to 2023 is shown in Figure 2. A clear upward trend over time can be observed, indicating the increased role of scientific research in environmental conservation from Islamic perspectives. The studied period can be divided into four stages: the first stage, from 1959 to 1980; the second stage, from 1980 to 2004; the third stage, from 2004 to 2013; and the fourth stage, from 2013 to 2023. The number of publications at the flat par in the first stage. At the second stage, it fluctuated from 1980 to 2004, with less than seven papers each year. In the third stage, it increased from 2004 to 2013 and dramatically in the fourth stage. This trend shows that this topic is receiving increasing attention, and more studies are being performed.

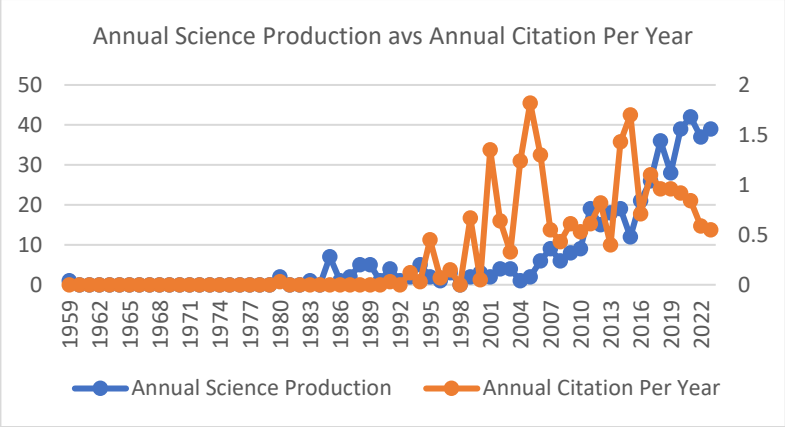

Figure 2: Number of annual scientific production from 1980 to 2023

Annual citation per year shows four stages: the first stage from 1959 to 1992, the second stage from 1992 to 2007, the third stage from 2007 to 2015, and the fourth from 2015 to 2023. The first stage shows no annual citation per year, except in 1980 with 0.03. The second stage fluctuated rapidly, indicating inconsistency of citation during this period. The third stage shows an increasing pattern of annual citations per year. However, the fourth stage shows that the pattern is slowly decreasing, which contradicts the amount of paper produced. Based on this observation, two research questions can be posed: i) Which authors and journals lead the literature related to this study are cited the most, and ii) What are the main topics that were researched and which countries contributed the most?

Table 3: Top 10 journal publications

Ranking	Journals	Number of Articles	Percent (of 450)
1	IOP Conference Series: Earth and Environmental Science	16	4
2	Department of State Publication. Background Notes Series	15	4
3	International Journal of Environmental Science and Technology	7	2
4	Journal of Islamic Marketing	6	2
5	Samarah	5	1
6	Advances in Science, Technology and Innovation	4	1
7	Journal of Environmental Studies	4	1
8	Pertanika Journal of Social Sciences and Humanities	4	1
9	Planning Malaysia	4	1
10	Religions	4	1
Ranking	Affiliation (Country)	Number of Articles	Percent (of 450)
1	Universiti Kebangsaan Malaysia (Malaysia)	25	5
2	Islamic Azad University (Iran)	13	3
3	University of Malaya (Malaysia)	11	2
4	Universiti Sains Islam Malaysia (Malaysia)	9	2
5	Universiti Malaysia Kelantan (Malaysia)	8	2
6	Qatar University (Qatar)	7	2
7	Tehran University of Medical Sciences (Iran)	7	2
8	Umm Al-Qura University (Saudi Arabia)	7	2
9	University of Florence (Italy)	7	2
10	University of Tabuk (Saudi Arabia)	7	2

Ranking	Subject categories	Frequency	
1	Social sciences	194	47
2	Arts and humanities	85	21
3	Environmental science	37	9
4	Engineering	25	6
5	Business	21	5
6	Economics	17	4
7	Computer science	15	4
8	Energy	11	2
9	Medicine	4	1
10	Mathematics	3	1

The bibliometric analysis results related to each research area are presented in Table 3. The subject category was based on the types of journals in the Scopus database. The ranking results reveal that the highly published papers in this field are the IOP Conference Series: Earth and Environmental Science (4%) and the Department of State Publication. Background Notes Series (4%) and Journal of Islamic Marketing (2%). For the affiliation, rank one is produced by Universiti Kebangsaan Malaysia with 25 articles (5 per cent), and rank two is produced by Islamic Azad University (Iran) with 13 articles (3 per cent). Islamic countries dominate the ranking. The top 10 subject categories in terms of frequency include social sciences (the highest frequency, 194), Arts and humanities (the second-highest frequency, 85), and environmental science (the third-highest frequency, 37). In addition, there are other subjects, such as engineering, business, and economics.

3.2 The most influential authors, organisations, and countries

The top ten cited authors, and their respective organisations are presented in Table 4. It shows that the UK has three authors from the top ten list (Baik et al.) and two from Malaysia, both from Universiti Sains Malaysia (Hassan & Hamidu).

Table 4: Top 10 cited authors

Authors	Title	Journal	Affiliation	Quarter (H-index)	Citation
Baik et al. (2015)	Integration of Jeddah historical BIM and 3D GIS for documentation and restoration of historical monument	International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives	University College London, United Kingdom	Q1 (82)	68
Bhatia et al. (2017)	The Relationship Between Religion and Attitudes Toward Large Carnivores in Northern India?	Human Dimensions of Wildlife	Nature Conservation Foundation, India; Snow Leopard Trust, United States; Manipal University, India	Q2 (59)	64
Lopez-Arce & Garcia-Guinea (2005)	Weathering traces in ancient bricks from historic buildings	Building and Environment	Centro Tecnologico de Materiales, Spain; Museo	Q1 (189)	57

			Nacional de Ciencias Naturales, Spain		
Hamidu et al. (2015)	Corporate social responsibility: A review on definitions, core characteristics and theoretical perspectives	Mediterranean Journal of Social Sciences	University of Technology, Nigeria; Universiti Sains Malaysia, Malaysia	Q4 (30)	52
Seed (2015)	Sustainability in the Qatar national dietary guidelines, among the first to incorporate sustainability principles	Public Health Nutrition	Supreme Council of Health, Qatar	Q2 (156)	42
Sutton & Fahmi (2002)	The rehabilitation of Old Cairo	Habitat International	University of Manchester, United Kingdom; University of Helwan, Cairo, Egypt	Q1 (102)	42
Mangunjaya & McKay (2012)	Reviving an Islamic approach for environmental conservation in Indonesia	Worldviews: Environment, Culture, Religion	Universitas Nasional, Indonesia; University of Kent, United Kingdom	Q4 (17)	41
Li et al. (2014)	Effects of land use changes on soil erosion in a fast-developing area	International Journal of Environmental Science and Technology	Chinese Academy of Sciences, Guangzhou, China	Q2 (93)	39
Kula (2001)	Islam and environmental conservation	Environmental Conservation	University of Ulster at Jordanstown, United Kingdom	Q1 (97)	39
Arafat (2013)	Combined in situ micro-XRF, LIBS and SEM-EDS analysis of base metal and corrosion products for Islamic copper alloyed artefacts from Umm Qais museum, Jordan	Journal of Cultural Heritage	Technical University of Berlin, Germany	Q1 (78)	35

Baik et al. (2015) have 68 citations, and they investigated the digital method for documenting and restoring historical monuments. It was followed by Bhatia et al. (2017) with 64 citations, and his study proposed to integrate local religious philosophies into conservation practices. Ahmad & Hassan (2007) have 58 citations, and Lopes-Arce & Garcia-Guinea (2005) has 57 citations. In summary, this topic can be divided into Islamic technologies, cultural, historical, and environmental conservation.

Further analysis (Figure 3) identifies and investigates the country's scientific production in the literature on environmental conservation from Islamic perspectives. Indonesia has the highest scientific production with 18 articles, Malaysia has 13, and Iran has 6. The United Arab Emirates and the United Kingdom have three articles. In addition, Canada, Egypt, and India have two articles.

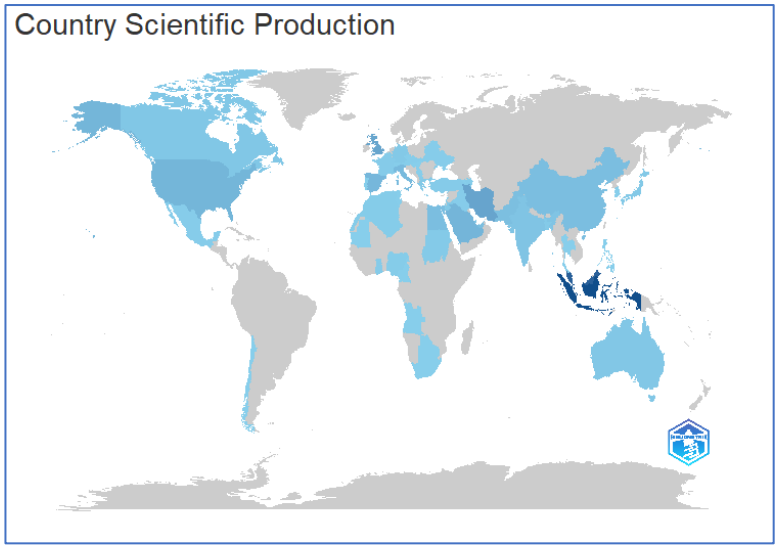

Figure 3: Country Scientific Production on environmental conservation in Islamic perspectives

3.3 Result of co-citation analysis

Figure 4 presents a cluster analysis of the most common keywords used by authors in the literature over the past 70 years. This study can also help identify emerging topics for the future. In this type of map, colours represent different clusters, and clusters are based on relationships. In the map, each keyword is represented by a circle. Co-occurrence analysis of all keywords was applied to conceptualise the development and growth of environmental conservation from an Islamic perspective. This analysis is done by selecting the type of analysis (co-occurrence) and unit of analysis (author keywords).

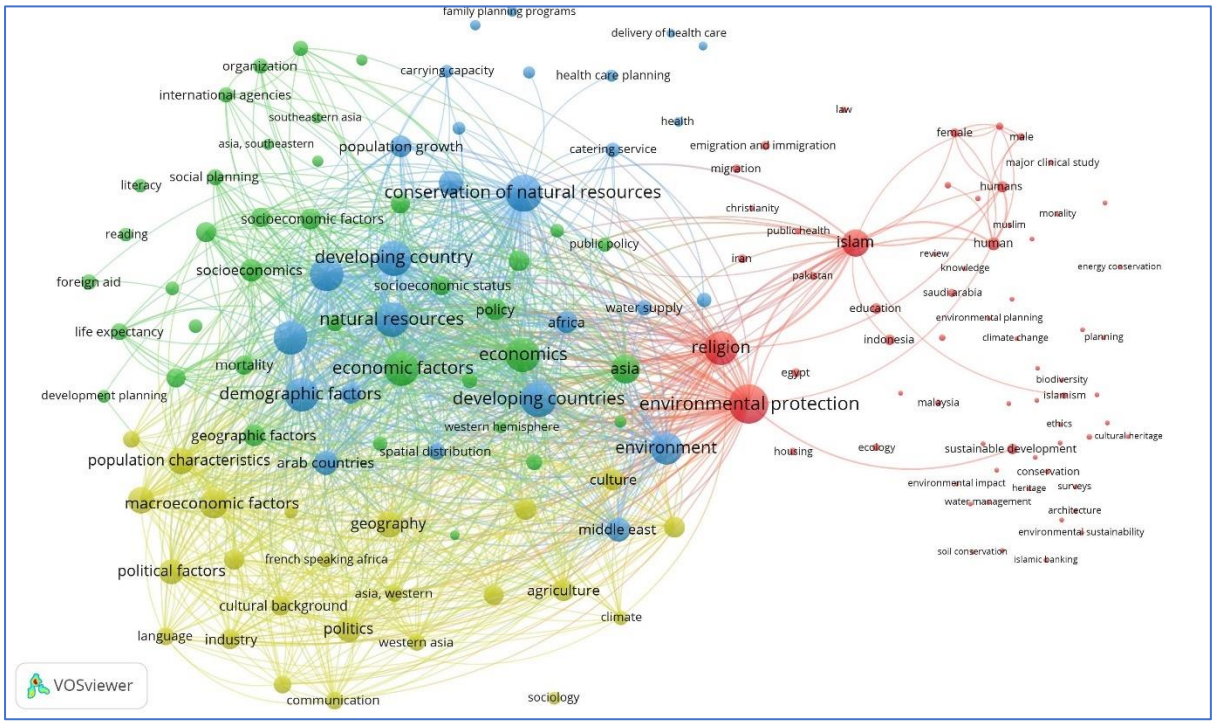

Figure 4: Co-0ccurrence analysis using VOSviewer

A minimum threshold of two for the occurrence of a particular keyword was required and filtered to arrive at a meaningful analysis. This resulted in 158 keywords for 450 papers, referring to studies between 1959 to 2023. The results are reported in Figure 4 and show that the most frequently used words are environmental protection, religion, and Islam. Overall, the keywords that appeared with the highest frequency in the selected articles were environmental protection (72 times), developing countries (64 times), economics (61 times), Islam (59 times), religion (50 times), environment (49 times), conservation of natural resources (38 times), natural resources (30 times).

These findings indicate a growing interest in this field. Nodes on the map represent every keyword. The diameter shows how many connections there are to other keywords. More linkages with additional terms would indicate a broader node. The line's thickness between two nodes indicates how frequently the keywords appear together. In this study, the frequent occurrence of these keywords among studies reflects more analyses applied to the Islamic environmental conservation field. As shown in Figure 2, there are four major clusters: environment protection and sustainable development in Islam (red), economic factors in developing countries (green), natural resources in developing countries (blue), and socioeconomics in south-eastern countries (green).

Referring to the clusters, there are three groups of studies as below: i) environment protection and sustainable development from an Islamic perspective (Mangunjaya & McKay, 2012; Koehrsen, 2017); ii) economics protection from an Islamic perspective (Hassan, 2014; Ahmad & Hassan, 2007; Siyavoosh et al., 2019) and iii) issues of environmental problem, socioeconomic and religion towards Islamic perspectives. Dividing the study period into sub-periods can help discover the changes and evolution of leading research themes in environment conservation analysis over time. Thus, emerging topics (Table 5) are identified using VOSviewer, and analysis uses time series analysis by slicing into several subperiods with an appropriate period.

Table 5. Slicing analysis

1980-1985	1986-1990	1991-1995	1996-2000	2001-2005	2006-2010	2011-2015	2016-2020
rural development	environmental protection	education	primary health care	architecture	environmental management	controlled study	environmental conservation
agricultural development	macroeconomic factors	health education		heritage conservation	water management	Islamism	environmental education
social planning	environment			environmental impact	nature conservation	biodiversity	surveys
development planning	religion				environmental planning	soil conservation	sustainability
population characteristics	conservation of natural resources				sustainable development	biotechnology	conservation management
carrying capacity	population dynamics and growth				historic preservation		
urban and rural population	international cooperation				ethics		
	water supply						
	Islam						

Each subperiod text data can be seen as a topic. All keywords are screened, and all keywords of countries/regions are deleted as listed: India, Africa, China, Iran, United States, Southern Asia, Malaysia, Eurasia and Saudi Arabia. First, from 1980 to 1990, keywords focus on theory subject matters, such as the urban and rural population, social and economics, and the environment (protection and conservation). In the timeline 1991-2000, fewer articles were found; thus, keywords focused on education and health care. The keywords trend changed in the timeline 2001 -2010, focusing on more practical subjects such as environmental and water management, historic preservation, biotechnology, nature conservation, and sustainable development. Lastly, the 2011-2020 timeline shows highly conducted educational studies on sustainability, looking at the survey keywords, controlled study, environmental education, and sustainability. Studies also focus on soil conservation, biotechnology, and Islamism, which explains that these keywords are the future trends of this theme.

Further analysis (Figure 5) shows that nodes and links represent the bibliographic coupling, and the colour of nodes and lines represents different years. The bibliographic coupling of the authors formed 15 clusters, as shown in Figure 3. There was a group of primary authors with high indices of bibliographic coupling of 14 authors (red cluster). This group has the highest link strength; the authors, including Amin (2013), Dudley (2014), Farook (2016), Hasim (2020), Hasin (2022), Ibrahim (2011), Iswahyudi (2022), Mangunjaya (2012), McKay (2014) and others. The remaining cluster has several authors, from 4 to 12.

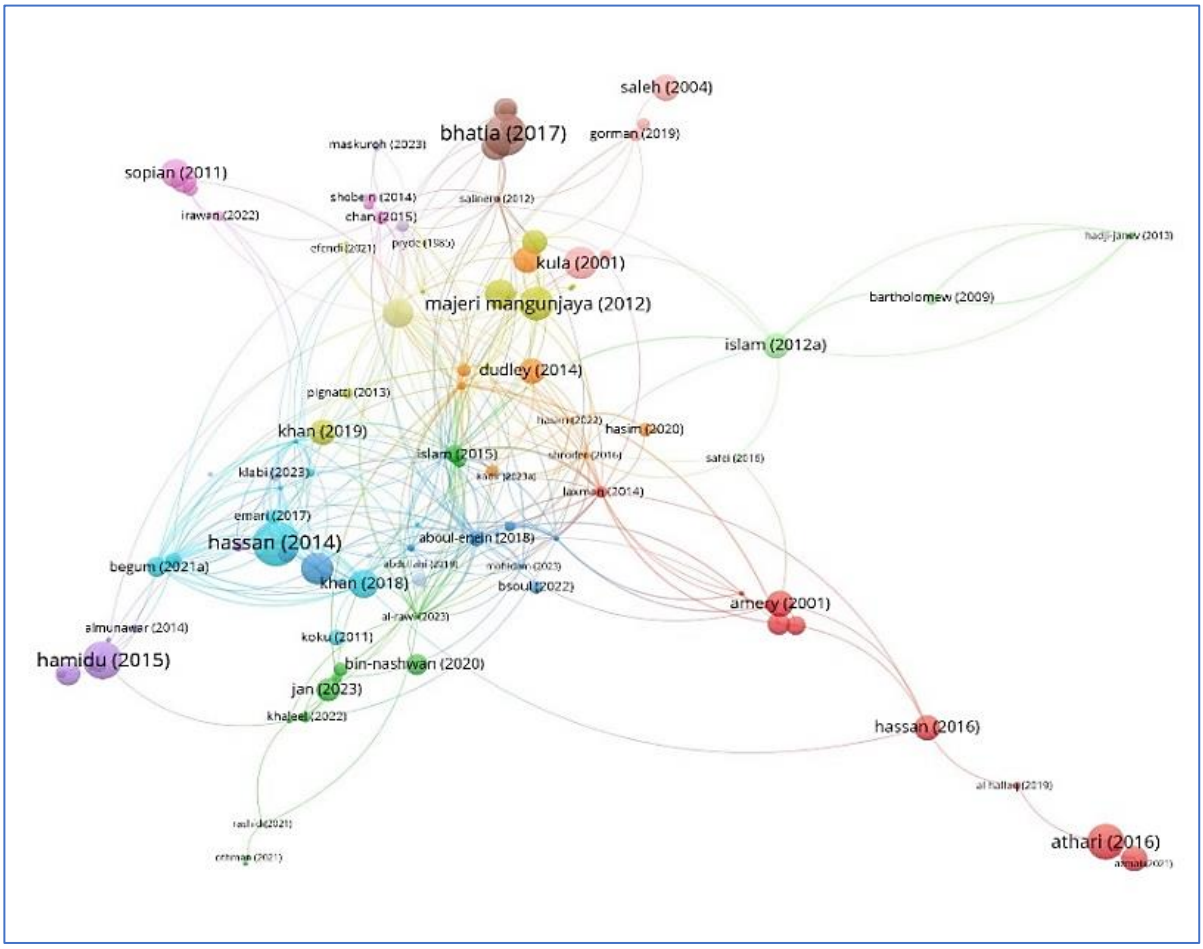

Figure 5: Bibliographic coupling

4.0 Conclusion

This study focuses on environmental conservation from Islamic perspectives to gain clearer insights into trends and historical developments through bibliometric methods. Although this study started earlier (1959), it shows a slow progress from 1960 to the 1990s. Nine out of ten affiliations originate from Islamic countries, suggesting that Islamic countries dominate the list.

The top ten cited authors and their respective organisations show that the UK has three top ten authors, two Malaysian authors, and both from Universiti Sains Malaysia. Further research shows that Indonesia generated the most scientific articles (18), followed by Malaysia (13) and Iran (6). The keywords that appeared with the highest frequency in the selected articles were environmental protection (72 times), developing countries (64 times), economics (61 times), Islam (59 times), religion (50 times), environment (49 times), conservation of natural resources (38 times), natural resources (30 times). The cluster analysis shows the findings of this study. The three groups of studies are: i) environment protection and sustainable development from an Islamic perspective, ii) economic protection from an Islamic perspective, and iii) issues of environmental problems, socioeconomic and religious towards Islamic perspectives.

Environmental conservation is a wide context and can be seen from the physical, social and economic perspective. Theoretical and practical reasons explain why understanding environmental conservation from the Islamic perspective is important (Gari, 2006; Kula, 2001; Mangunjaya & McKay, 2012). Thus, the interest of scholars in environmental conservation from an Islamic perspective has significantly increased over the past decade. Although some excellent reviews have been conducted (Koehrsen, 2020), discoveries about the updated scientific structure of environmental conservation, specifically from an Islamic perspective, still need to be made available.

A thorough mapping of this subject is required to obtain a comprehensive scientific framework that aids in forecasting future research paths in environmental protection. By bibliographic studies, this study investigates the scientific structures and connections among the foundational articles on the subject of environmental conservation by bibliometric analysis of research in this area. More precisely, an overview of this promising research theme's intellectual structure is provided by combining three bibliometric analysis methods: bibliographic coupling, co-citation, and co-word analyses. This enables researchers to locate their work in this field and pursue new avenues for future research. Results from bibliographic coupling analysis show that publications with the highest indices of bibliographic coupling are Hassan (2014), Mangujaya (2012), Kula (2012), Bhatla (2017) and Athari (2016). Results of keyword analysis show some suggestions for future research directions such as environmental education, sustainability and education sustainable development, environment protection and sustainable development in Islam, evaluation of natural resources and impact of socioeconomics towards environmental conservation.

The knowledge this study provides about environmental conservation from an Islamic perspective is anticipated to inspire future researchers to work on this burgeoning topic. Furthermore, the outcomes of bibliographic analysis assist researchers in placing their

ongoing studies in context and in identifying new avenues for future research. Lastly, policymakers can easily obtain academic information and an overall understanding of environmental conservation from Islamic views that can be implemented into practice thanks to this research's scientific framework of environmental conservation from Islamic perspectives. This is the first study that combines co-citation, co-word, and bibliographic coupling analyses with an examination of published works on environmental conservation. First off, Scopus provides the data sources for this study. Future research may include a larger range of data sources to ensure that no studies are overlooked. Second, by classifying and using keywords, other analytical methods like correspondence analysis can better understand and identify fresh patterns in social entrepreneurship. Lastly, the review's reliance on citation counts over an extended period obscures the significance of recently published research.

Acknowledgement

The authors would like to sincerely thank the International Institute of Islamic Thought and the International Islamic University Malaysia for their generous sponsorship of this research (IIIT-SRP24-036-0036).

References

Abdelzaher, D. M, Kot, A. & Helfay, A. (2019). Eco-Islam: Beyond the Principles of Why and What, and Into the Principles of How, *Journal of Bus Ethics*, 155, 623–643

Ahmad & Hassan (2007). Regulation and performance of Islamic banking in Bangladesh, *Thunderbird International Business Review*, 49 (2), 251 – 277.

Ahmed, A. A. A. (2012). Accounting from an Islamic perspective: A timely opportunity is a timely challenge. *ASA University Review,* 6(2), 11–31.

Athari S.A., Adaoglu C. & Bektas E., (2016). Investor protection and dividend policy: The case of Islamic and conventional banks, *Emerging Markets Review*, 27, 100-117.

Baik A., Yaagoubi R., Boehm J. (2015). *Integration of Jeddah historical bim and 3D GIS for historical monument documentation and restoration*, International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives, 40.

Bazina, K. O. R., Mokhtar, A. I. & Kamarudin, M. A. (2023). The concept of Islamic sustainable development in human civilisation: Perceptions of Climate Change and its mitigation, International Journal of Advanced Research, Vol. 11 (12). 1072-1080.

Bhatia S., Redpath S. M., Suryawanshi K., Mishra C. (2017). The Relationship Between Religion and Attitudes Toward Large Carnivores in Northern India?, *Human Dimensions of Wildlife*, 22(1).

Chaudhry, S. (2022). Environmental Stewardship: Perspectives from the Islamic Teachings, African Journal of Sociological and Psychological Studies (AJOSAPS), Vol. 1 (1), 121-138

Ding, X. & Yang, Z. (2020). "Knowledge mapping of platform research: a visual analysis using VOSviewer and CiteSpace", *Electronic Commerce Research*, 1–23.DOI 10.1007/s10551-017-3518-2

Donthu, N., Kumar, S., & Pattnaik, D. (2020). Forty-five years of Journal of Business Research: A bibliometric analysis. *Journal of Business Research*, 109(October 2019), pp. 1– 14. https://doi.org/10.1016/j.jbusres.2019.10.039

Eck, N. J. V. & Waltman, L. (2023). *VOSviewer Manual*. Universiteit Leiden, January 2023.

Ellili, N.O.D., (2023). Bibliometric analysis of sustainability papers: evidence from environment, development and sustainability. *Environment, Development and Sustainability.* https://doi.org/10.1007/s10668-023-03067-6

Emari, H., Vazifehdoust, H. and Nikoomaram, H. (2017). Islam and Environmental Consciousness: A New Scale Development, *Journal of Religion Health*, 56, 706–724

Gari, L. (2006). *"A History of the Hima Conservation System". Environment and History*. The White Horse Press, Cambridge, UK. 12 (2): 213–228. doi:10.3197/096734006776680236

Greenfield, P. (2020). Humans exploiting and destroying nature on an unprecedented scale – report. https://www.theguardian.com/environment/2020/sep/10/humans-exploiting-and-destroying-nature-

on-unprecedented-scale-report-aoe
Hamidu et al. (2015). Corporate social responsibility: A review on definitions, core characteristics and theoretical perspectives, *Mediterranean Journal of Social Sciences*, 6 (4).
Hjørland, B. (2013). Facet analysis: The logical approach to knowledge organisation. *Information Processing and Management, 49*(2), 545–557.
Ibrahim Hazim (1985). *Al-Khawass Al-Qur'aniyyah wa Shumuliyyat Al-Hasr*,`Aalam Al-Binaa' magazine, July issue, Cairo.
Ibrahim (2011). Ibrahim P.; Basir S.A.; Rahman A.A., Sustainable economic development: Concept, principles and management from an Islamic perspective, *European Journal of Social Sciences*. 24 (3).
Ismail, M. S., Ramli, A., & Darus, F. (2014). Environmental management accounting practices and Islamic corporate social responsibility compliance: Evidence from ISO14001 companies. *Procedia-Social and Behavioral Sciences, 145*, 343-351.
Iswahyudi (2022). Cosmology and social stratification of the Madurese population in the XIX century, *Cogent Arts and Humanities*. 9(1).
Kamarrudin, H., Talib, O., Kamarudin, N., & Ismail, N. (2022). Examining the Trend of Research on Active Engagement in Science Education: Bibliometric Analysis. *Journal of Turkish Science Education*, 19(3), 937–957. https:// doi.org/ 10.36681/used.2022.157
Kent Baker, H., Pandey, N., Kumar, S., & Haldar, A. (2020). A bibliometric analysis of board diversity: Current status, development, and future research directions. *Journal of Business Research*, 108(August 2019), pp. 232–246. https://doi.org/10.1016/j.jbusres.2019.11.025
Koehrsen J. Muslims and climate change: How Islam, Muslim organisations, and religious leaders influence climate change perceptions and mitigation activities. *WIREs Clim Change*. 2021; 12:e702. https://doi.org/10.1002/wcc.702
Llewellyn, O. A., (2003). 'The Basis for a Discipline of the Islamic Environmental Law', in R. C. Foltz et al., Islam and Ecology, (Cambridge: Mass.: Center for the Study of World Religions, Harvard Divinity School; Harvard University Press.
Lopez-Arce & Garcia-Guinea (2005). Weathering traces in ancient bricks from historic buildings, *Building and Environment*, 40 (7).
Mangunjaya F. M & McKay J. E. (2012). Reviving an Islamic approach for environmental conservation in Indonesia, *Worldviews: Environment, Culture, Religion*, 16 (3).
Mihlar, A.M.M, Rahman, M.R.A., Mahyuddin, M. K., Mokhtar, A. N. & Ahmad, Y. (2016). Religious Harmony and Peaceful Co-Existence: A Quranic Perspective. *Journal of Islamic Social Sciences and Humanities*. 7. 47-62.
Muhammad, G., Shah-Kazemi, R. and Ahmed, A. (2010). *The Holy Qur'an and the Environment*. The Royal Aal Al-Bayt Institute for Islamic Thought. Kingdom of Jordan.
Naqvi, Syed Nawab Haider. *Ethics and Economics: An Islamic Synthesis*. United Kingdom: The Islamic Foundation, 1981. Islam, Economics and Society. London: Kegan Paul International.
Nik Hassan, N. M. H., Talib, O., Shariman, T. P., Rahman, N. A., & Zamin, A. A. M. (2022). A Bibliometric Analysis on How Organic Chemistry Education Research Has Evolved Collaboratively Over Time. *Jurnal Pendidikan IPA Indonesia*, 11(1), 73–90. https://doi.org/10.15294/jpii.v11i1.34185
Platonova E (2013). Corporate social responsibility from an Islamic moral economy perspective: a literature survey. *Afro Eurasian Stud* 2:272–297
Puspitarini, D., Degeng, I. N. S., Praherdhiono, H., & Suryati, N. (2023). Humanistic Pesantren: Systematic Literature Review and Bibliometric Visualization Analysis on Character, Moral, and Ethical Values. *Pertanika Journal of Social Sciences and Humanities*, 31(2), 465–490. https://doi.org/10.47836/PJSSH.31.2.01
Sayem, M. A. (2021). Islam and Environmental Ethics: A Qur'ānic Approach, *Islamic Studies* 60:2 (2021) pp. 157–172.
Sci2 Team. (2009). Science of Science (Sci2) Tool. Indiana University and SciTech Strategies, https://sci2.cns.iu.edu.
Seed (2015). Sustainability in the Qatar national dietary guidelines, among the first to incorporate sustainability principles, *Public Health Nutrition*, Vol. 18 (3). Pp. 2303 – 2310.
Sutton K., Fahmi W. (2002). The rehabilitation of Old Cairo, Habitat International, Vol. 26 (1).
Tan Luc, P., Xuan Lan, P., Nhat Hanh Le, A. and Thanh Trang, B. (2020). "A co-citation and co-word analysis of social entrepreneurship research", *Journal of Social Entrepreneurship*, 13 (3), 324-339.
Van Eck, N.J. and Waltman, L. (2017), VOSviewer Manual, Univeristeit Leiden, Leiden, 1-8.
Siyavooshi M., Foroozanfar A., Sharifi Y. (2019). Effect of Islamic values on green purchasing behaviour, *Journal*

of Islamic Marketing, 10 (1), 125 – 137.

Amin L., Fairuz Sujak S., Latif Samian A., Sabri Haron M., Nasran Mohamad M. (2013). Decision making on agro-biotechnology issues: An Islamic perspective, *Journal of Food, Agriculture and Environment*, 11. 1207 – 1215.

Dudley N., MacKinnon K., Stolton S. (2014). The role of protected areas in supplying ten critical ecosystem services in drylands: A review, *Biodiversity*. 15.

Farook F., Din N., Razali M.A., Ismail A. (2016). *Profundity in maxims of Eco-Islam among hospitality students.* [Paper presentation]. Heritage, Culture and Society: Research agenda and best practices in the hospitality and tourism industry - Proceedings of the 3rd International Hospitality and Tourism Conference, IHTC 2016 and 2nd International Seminar on Tourism, ISOT 2016.

Hasim N.A.; Amin L.; Mahadi Z.; Yusof N.A.M.; Ngah A.C.; Yaacob M.; Olesen A.P.; Aziz A.A. (2020). The Integration and Harmonisation of Secular and Islamic Ethical Principles in Formulating Acceptable Ethical Guidelines for Modern Biotechnology in Malaysia, Science and Engineering Ethics. 26 (3).

Wardi F., Suhaimi, F. M., Saffinee, S. S. (2023). Syariah and Law Studies in Facing the Contemporary Challenges" 388, Preservation of animal rights in Islamic jurisprudence. The 4th International Conference of the Postgraduate Students and Academics in Syariah and Law 2023 (INPAC 2023)

JOURNAL OF ARCHITECTURE, PLANNING & CONSTRUCTION MANAGEMENT
Volume 14 Issue 2, 2024 E-ISSN: 2462-2222 ISSN: 2231-9514

THE BEST HEALTHY SPATIAL DESIGN REQUIREMENTS FOR PRESCHOOL CHILDREN IN CHINA

Received: 25 July 2025 | Accepted: 22 September 2024 | Available Online: 7 December 2024
DOI: 10.31436/japcm.v14i2.911

Maszura binti Abdul Ghafar[1]*, Zhou Yajing[2]

*[1]*Department of Architecture, Faculty of Design and Architecture Universiti Putra Malaysia, maszu@upm.edu.my*
[2]Department of Architecture, Faculty of Design and Architecture Universiti Putra Malaysia, gs64188@student.upm.edu.my

Corresponding author: **Maszura binti Abdul Ghafar, Corresponding author's email: maszu@upm.edu.my*

ABSTRACT

In China, preschool education is the initial educational Environment for children. Early childhood education focuses on six key aspects of children's development: religious and moral values, physical activity, cognitive skills, social skills, language skills, and creativity. Therefore, many researchers believe that one way to nurture these six areas is to create an atmosphere that meets children's requirements, such as providing comfort, safety, and stimulation. Nevertheless, the state of many Preschool children needs more joyful school hood in China nowadays. This situation has resulted in the deterioration of the children's well-being and development. This study conducted a systematic literature review synthesis process to evaluate the trend, identify the gaps, and recommend the best healthy spatial design requirements for preschool children in China. This study covers current healthy spatial design requirements for children regarding kinaesthetic learning, preschool children's healthy spatial design activities applications such as cultural games, and successful design requirements for preschool children's healthy development in China. This study conjectures that when cultural game spaces are designed to strengthen pre-schoolers' kinaesthetic learning in an educational environment, it could strengthen pre-schoolers' happiness, fun, and enjoyment. The findings would benefit policymakers and stakeholders in designing a fun, positive, and cultural engagement Environment for preschool children's thorough physical activity space criteria that can improve the overall well-being of preschool children.

Keywords: cultural games, healthy development, preschool children, preschool space design

1.0 INTRODUCTION

Since July 2, 2001, the Chinese government has implemented school policies such as the Guideline for Kindergarten Education and the guidelines for assessing the quality of kindergarten care and education (Li, 2001; Zhuang Bi et al., 2015). These guidelines prioritise towards age-specific features and development that emphasise pre-schoolers' comprehensive and continuous growth. The policy's directive requires incorporating teaching games for pre-schoolers to support children's physical and cognitive growth. Unfortunately, few preschools in China provide age-specific features and development, emphasising pre-schoolers' comprehensive and continuous growth. This feature can be seen in how preschool children reflect on their schoolhood, happiness, and well-being.

In 2020, a study (Guan et al., 2020) of China's children indicated that 11.1% of China's children

are overweight and 7.9% are obese, and this is a rising trend (Ji et al., 2004; Daniels et al., 2005; Abarca-Gómez et al., 2017; Zhao, 2018; Chen et al., 2020). This serious condition has made China's government realise that there is underlying instability in Health issues of children aged 3 to 6 and the physiological risks (Fu, Xiaolan, et al., 2023). These health issues have a direct impact on the growth and development of children. Policies, infrastructure, organisational structures, and environmental protections affect preschool children's migration (Lubomira, 2004; Hao et al., 2021).

China is a culture-influence-society that could affect one's worldview, values, and conduct, and it is believed that it would enhance cognitive skills, self-esteem, and society's adaptability (Hu et al., 2021). A positive social environment and culture would aid preschool children in learning to follow norms and create a sense of identity and belonging. This situation could benefit their physical and mental health and development and provide preschool children with safer and healthier spaces, facilities, and services to promote the harmonious development of their bodies and minds. Similarly, it would allow preschool children to enjoy a healthy and interesting environment for cultural and physical activities (Ingold, 2002). Therefore, this study saw a need to provide fun school spaces for a better preschool experience, particularly in China. Here, the study seeks the best healthy spatial design requirements for preschool children in China.

2.0 RESEARCH METHODOLOGY

Masiran et al. (2020) developed a Systematic Literature Review Synthesis Process based on Ibrahim and Mustafa Kamal (2018). This is a typology of literature review that elucidates existing literature during the initial stages of research ideation (Rousseau et al., 2008; Yu & Watson, 2019; Templier & Paré, 2015). Ibrahim (2011 & 2020) suggested three RQ structures— “who”, “what”, and “how”—to establish research themes. The “who” is the affected factor, the “what” is the required knowledge, and the “how” is the target impact of the study. Based on the kinaesthetic learning of pre-schoolers, the identification of cultural game preferences for healthy pre-schooler development, and the recommendation of space design features needed for healthy pre-schooler development in China, this study recommended the optimal space design requirements for healthy pre-schooler development in China. A systematic literature review synthesised and identified pertinent papers. The literature review program finds papers that could answer critical research topics. The selected papers will be studied in more depth to better understand the important findings of the study and provide support and areas of development for future research. This exercise produced a summary of the best narratives, which were later cross analysed to incorporate possibilities and prioritise how to incorporate cultural games into the optimal design of preschool spaces needed for the healthy development of pre-schoolers in China, how to enhance kinaesthetic learning while bringing fun and enjoyment to pre-schoolers while they are in preschool. The “Point of Departure (POD) Tree Diagram” by Ibrahim and Mustafa Kamal (2018) summarises the important findings. The study recorded the synthesis process using the EAGLE Navigator online system and reported the results.

3.0 LITERATURE REVIEW

This literature survey study investigates preschool children’s kinaesthetic learning, identifies cultural game preferences for pre-schoolers' healthy development, and recommends the

spatial design characteristics needed for healthy preschool development for children in China. Through selecting literature from the Web of Science and Google Scholar, using the keywords, this study recommends the best healthy spatial design requirements for preschool children in China. Towards its conclusion, this study presents descriptive findings that lead towards the potential theoretical direction of how spatial design of experiential-cultural spaces requirements for pre-schoolers could strengthen kinaesthetic learning whilst giving fun and enjoyment to the pre-schoolers during school hours.

3.1 Healthy Spatial Design for Preschool Children

Early childhood education is a critical factor in the subsequent development of preschool children's cognitive abilities, social interactions, and emotional intelligence. It is the initial stage in their overall growth and is pivotal in shaping these aspects. At this level, learning encompasses not only acquiring knowledge but also serving as the foundation for cultivating competencies and abilities. During this phase, there is a specific focus on developing and honing their spatial thinking abilities. This thinking significantly impacts their ability to comprehend spatial relationships, solve problems, and exercise their creative imagination (Hatira & Sarac, 2024). Gardner and Hatch (1989) proposed that cognitive science and education increasingly focus on the motor components of learning. Motor participation in learning has received significant study in cognitive science and educational research. This focus is evident in theoretical investigations and the creation and execution of practical exercises designed to help learners better understand and utilise information. Specifically, studies on physical education and kinaesthetic learning indicate that including movement and contact in the teaching and learning process is beneficial. Notable research has been conducted on physical education (Williams et al., 2008) and kinaesthetic learning (Lengel & Kuczala, 2010). These studies indicate that incorporating suitable physical activities and interactive communication into the educational process can significantly improve students' involvement and enthusiasm for learning. By employing this approach, intangible ideas may become tangible, and comprehension can be enhanced by making information more vivid and accessible.

3.2 Preschool Children’s Kinaesthetic Learning

Kinaesthetic learning is crucial for young children (Lengel & Kuczala, 2010), such as pre-schoolers. The kinaesthetic methods are for children to acquire knowledge through engaging in active physical activities instead of passive listening (Yıldız et al., 2024). Kinaesthetic learning involves fundamental, potent, and widespread methods for acquiring knowledge (Grønbæk et al., 2007). Often, kinaesthetic learning in young children could cause stress due to the physical learning process of gaining knowledge and skills (Agustia & Arifin, 2018). However, auditory learning (Agustia & Arifin, 2018), hands-on kinaesthetic practice (Fitzpatrick & Flynn, 2010), and personal experience (Gomez et al., 2000) could enhance learning in children (Lengel & Kuczala, 2010). This technique not `only promotes the enjoyment of learning but also enhances learning efficiency (Lengel & Kuczala, 2010). Sivilotti and Pike (2007) highlighted that kinaesthetic learning is a fundamental and potent learning method that transcends age, topic, and cultural barriers and is universally relevant in all educational systems. This study agrees with Wehrwein et al. (2007) that when a child possesses distinct learning style preferences, he or she will encompass visual learning through diagrams, charts, and flowcharts; auditory learning through phonics (Hanafiah et al., 2018);

literacy learning through reading and writing (Yahya & Noor, 2015); and kinaesthetic learning through touch, hearing, smell, taste, and sight (Kwon & Iedema, 2022). Based on the above arguments, this study conjectures that exploration stimulates children's senses and experiential learning is a direct experience. This method can improve children's healthy development during free play and the spatial characteristics of preschool indoor space.

The importance of exploration in preschool child development could boost healthy kinaesthetic learning. Studies (Van Liempd et al., 2018; Varman et al., 2021) found that during exploration, pre-schoolers learn new skills by watching and reacting to action possibilities, sensory, game stimulation (Ma et al., 2022), and experiential learning (Thompson, 2009). These learning methods boost children's cognitive and social development and curiosity about learning philosophically and pedagogically (Breathnach & O'Gorman, 2017). This study agrees with scholars that factors such as traditional festivals (Woodman, 2010) and Chinese traditional culture (Li, 2022) could aid pre-schoolers' understanding and respect and nurture children's cultural self-confidence (Li, 2022). In school spatial design, measures such as culturally themed play environments (Pui-Wah et al., 2015; Singh et al., 2016) could improve children's physical activity and socialisation. This study agrees with scholars (Li, 2022; Woodman, 2010) that when preschool spatial design is injected with cultural activities, it could boost kinaesthetic learning and grow culturally respected play areas tailored to children. Cultural exploration spaces, sensory, and games stimulation could boost healthy cognitive, moral, and stimulation for preschool children. This study foresaw that cultural games, kinaesthetic learning, and cultural game space design could support healthy spatial design for preschool children. Hence, these preferences give fun kinaesthetic pre-schoolers' learning spatial design programs and activities vis-a-vis promote a dynamic and inclusive learning environment. Therefore, this study conjectures that high-quality cultural game spaces are crucial to developing, nurturing, and supporting children to learn healthily.

3.3 Cultural Games for Pre-schoolers' Healthy Development

The design of preschool spaces directly impacts the healthy development of preschool children. Physical and mental health are among preschool children's healthy development areas. Physical health implies a healthy body; responsive, cognitive awareness, coordination, and adaptability (Carson et al., 2017; Lloyd et al., 2010; Cote et al., 2013; and Umer et al., 2017); and lifelong health (Telama et al., 2014). Here, this study foresaw that a good physical environment or spaces could prevent preschool children's obesity; a harmonious interpersonal environment or spaces could engage positive and stable emotions among children; and a healthy lifestyle will benefit children for life. The paper agrees with scholars (Bull et al., 2020; Kohl et al., 2012; and Bouchard et al., 2012) that Preschools in China involve daily activities, playful games, and sports for exercise (Li et al., 2022). Pre-schoolers need to have everyday activities of walks and household chores (Lipnowski et al., 2012), leisure play and dancing (Umo et al., 2019), and outdoor physical sports such as swimming and football to exercise (Tashpulatov & Shermatov, 2021). These activities are further categorised by Guan et al. (2020) to address pre-schoolers' energetic daily activities. (Refer to Table 1).

Table 1: Categorisation of physical activities typology for pre-schoolers (Adapted from Guan et al., 2020)

Type	Activities
Daily activities	Daily living skills (Soden, 2020) (eating with chopsticks, tying shoelaces, dressing, etc.)
	Household chores (washing small items, wiping the table, sweeping the floor, organising toys and your belongings, etc.)
Play games (basic motor skills development)	Posture-control games (Kovač et al., 2019): Golden chicken stand-alone, cross the log bridge, forward rolls, cartwheels, etc.
	Fine physical control games (Olabi, 2012): stringing beads, kneading playdough, origami, building blocks, etc. d. Physical fine control games: beads, playdough, origami, building blocks, etc.
	Sensitivity (Caillois, 2001): Eagle catching chickens, catching games, handkerchief throwing, etc.
	Coordination (Council, 2003): Climbing (climbing walls, climbing frames, and ladders, etc.), small animal crawling
Physical activities	Swimming, Gymnastics, Football, Basketball, Taekwondo, Wushu, Table Tennis, Baseball, Skating, etc.

Many early childhood educators need to emphasise game learning. The Learning and Development of Children Guidelines state pre-schoolers aged three to six need intuitive cognition, experiences, and play (Pan et al., 2018; Lin, 2014). This is due to children at that age learning about their environmental preservation and enhancement through adventurous skills development (Mou & Yingxue, 2003). This would allow preschool children to explore their Environment, practice their actions, discover new possibilities, and progress in all aspects of early childhood (Oudgenoeg-Paz et al., 2016). However, when teachers interject with structured education games, these games do not help preschool children's skills but worsen them (Mou & Yingxue, 2003). Here, this study agrees with Scholars those indoor games with sensory (Van Liempd et al., 2018), fun activities and interaction motivations (Tan & Rao, 2017), and folk games (Mok & Li, 2006) can encourage pre-schoolers to explore knowledge, build critical thinking and problem-solving skills. In the Chinese context, folk games have been fun and have encouraged explorative motivation and cultural learning. This study identified appropriate folk games for pre-schoolers that can enhance exploration and problem-solving skills. Meanwhile, Mok and Li (2006) believe that folk games can be categorised into four types: folk sports games, folk intellectual games, folk art games, and folk rhymes and raps. Therefore, Folk game resources are integrated into preschool's daily education, and corresponding folk game types of equipment are placed in various areas or classrooms in preschool environments to carry out related experiential, cultural game cognitive learning.

China is a multi-ethnic country, and it has accumulated various folk game resources (Long & Liang, 2011). The authors concur with Woodman (2010) and Choy (2017), who contend that children cannot grow up without a cultural context and that cultural environments have a significant ecological impact on children's development. The three main environments for a child's development are the home, the school, and society; the school is the greatest place for a youngster to spread culture. Children can more naturally engage with traditional Chinese culture through folk games (Lubomira, 2004). Nevertheless, in selecting the appropriate folk

games for pre-schoolers, any local school may need to identify the cultural values and symbols of the local community (Hofstede, 2001), for instance, in China. The lion dance has become a cultural value and symbol of the local community (Ji & Sirisuk, 2024). It has the merit of game-based teaching learning (Wang et al., 2024), physical activity (Xu et al., 2017), and interesting early childhood education (Yap, 2017). The lion dance can become popular again due to amusement and enjoyment passed down from generation to generation ethnically (Chen, 2017) and promote the children's well-being and health development (Varman et al., 2021; Mei & Luen, 2023). By engaging pre-schoolers with hands-on experience and reflection, they would be able to connect visual education to real-time experiential learning (Piscitelli & Penfold, 2015). Therefore, experiential learning can enhance fun cultural learning and entice preschool education. Hence, using experiential-cultural games learning space design could help children grow healthy and enjoy schoolhood.

3.4 Spatial Design Needs for Preschool Healthy Development in China

Integrating cultural games into pre-schoolers' school spatial design would boost their cultural awareness. Through these cultural spatial designs in school, consideration of national culture (Hofstede, 2001) needs to be critically viewed. This is because the national culture serves as the contextual and practice platform for programming cultural knowledge spatial design settings for pre-schoolers in China (Ghafar, 2018). For example, Chinese nations tend to have an authoritative figure, such as a teacher, to guide children in selecting what they can and should not do in school (Hofstede, 2001), whilst adventure-oriented school spaces could promote idea exchange (Lubomira, 2004). Since China is a collectivist country, it is keen on practical activities that emphasise community interests, a sense of belonging, and a willingness to contribute (Hao et al., 2021). This study denotes that the pre-schoolers' experiential-culture design spaces may need to be adventurous, respect the contextual culture, and contribute to being cheerful.

Since the 1950s, China has emphasised that their preschool children's intellectual program is cultivating curiosity, senses, and scientific traits (Maxwell, 2018). Preferences such as asking many questions, independent thinking, and pragmatism vision are among prudent traits needed in preschool learning (ibid.). However, when children have learning difficulties, they must deal with perception, feeling, and mobilities, interrupting their cognitive function and deteriorating their psychology and educational reasoning (Ayres, 1972). Here, this study foresaw that sensory integration spatial design (Zhou, 2021) could be one of the successful preferences to stimulate learning for pre-schoolers. Scholars recommended that bright colours (Lam & Ripman, 1977); odd-shaped activity spaces (Wang & Qin, 2017); and controlled hearing sensory (Zhou, 2021; Qian & Shih-Shi, 2021) could influence children's sensory and cognitive emotions (Maxwell et al., 2000; Lercher et al., 2002). In this case, alternatives such as Montessori's sensory teaching (Kenya, 2007), such as touch, sight, and smell (Li, 2019), could enhance pre-schoolers' muscle memory and stimulate them to learn new knowledge. This study agrees with Tarman and Tarman (2011) that there is a need for an experiential-cultural spatial design integration with the kinaesthetic-cultural games space for pre-schoolers. Therefore, when creating experiential-cultural game spaces in preschool, sensory integration is crucial in diversifying the kinaesthetic learning environment for pre-schoolers, which could stimulate their senses, adventurousness, and cultural dimension. They would enjoy and have fun in these cultural learning spaces during school hours.

Preschool children are keen and active in their natural outdoor surroundings (Storli et al., 2010). They are particularly keen on slopes (Kleppe, 2018), psychomotor learning games and equipment, and open spaces (Terrón-Pérezetal, 2021; McPhee et al., 2020). These preferences, when adhered to in their spatial Environment, could stimulate their happy feelings (Sutton-Smith, 1997), physical and mental health (Wisneski & Reifel, 2012), autonomous exploration (Van Liempd et al.,2018), and support learning and creativity opportunities (Gass et al., 2012). For instance, a cultural maze (Uttal, 2017) in preschool spaces, by using numerous cultural symbols or features, could instil pre-schoolers' learning behaviour of cultures (Dudek, 2005; Costantini, 2022). This cultural, spatial design could instil in children's thinking programming and behaviour harmony that respects cultural values, standards, and expectations. This study agrees with Click (2011) that cultural education should be part of healthy preschool environments. Five senses enhancement (Wang & Qin, 2017), such as vivid colours and visual arts (Thompson, 2009), would foster inquiry and engagement in children. This study foresaw that preschool experiential-cultural spaces could give joy, good well-being, and a comprehensive approach to their overall health. Kinaesthetic learning approaches are crucial for designing experiential-cultural preschool spaces that aid children's healthy development. Therefore, this study uses the Point of Departure (POD)Tree Diagram tool to integrate and summarise the conclusions of when experiential-cultural spaces have adhered to preschool spatial design in school; it could strengthen pre-schoolers' kinaesthetic learning in their educational Environment whilst giving fun and enjoyment to the pre-schoolers in Figure 1.

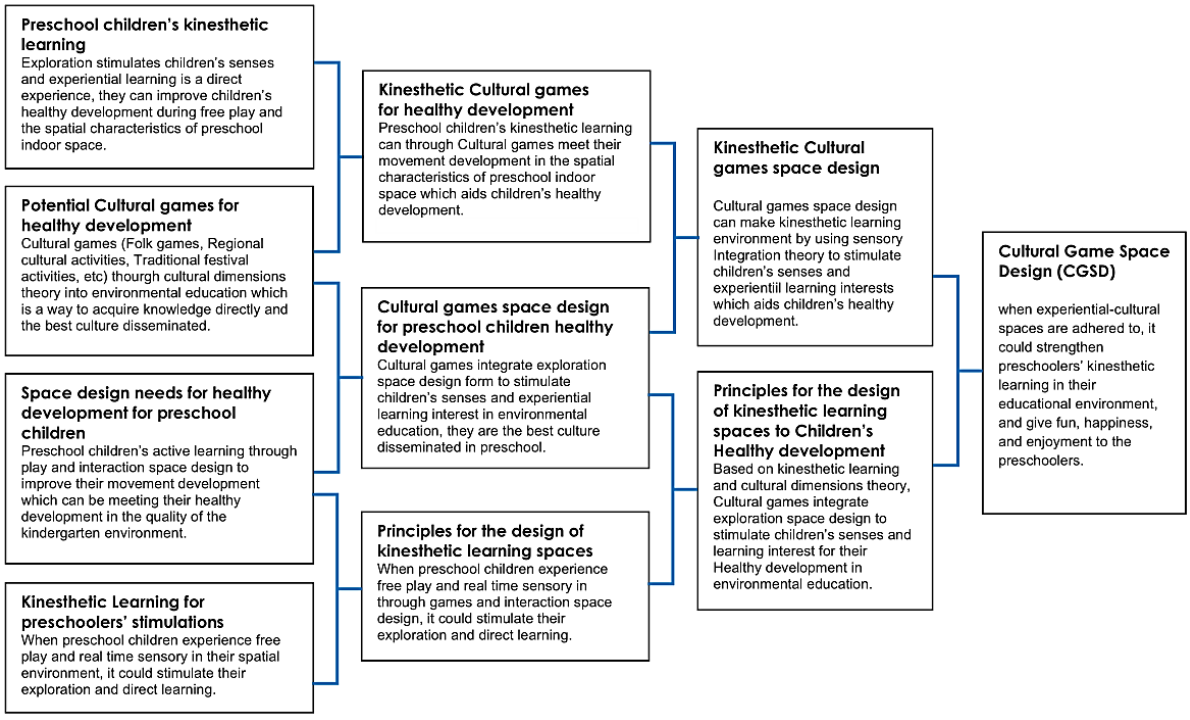

Fig 1: Point of Departure (POD) Tree Diagram for Study on healthy spatial design requirements for preschool children (Adapted from Ibrahim & Mustafa Kamal, 2018)

4.0 DISCUSSIONS

4.1 Designing Experiential-Cultural Spaces for Pre-schoolers' Kinaesthetic Healthy Development

In kinaesthetic-cultural spatial design, five sensory approaches (touch, hearing, smell, taste, and visual) are crucial to enable engagement, cognition, and joyous learning. Various forms of kinaesthetic-cultural spatial design that provide diverse teaching and learning methods (cultural games and physical activities) could accommodate children's needs and preferences in feeling adventurous and fun. Pre-schoolers engaged with kinaesthetic learning spatial design could extend their cognitive and mental well-being beyond the conventional classroom setting. This Experiential-cultural space and its realms could nurture adventure and fun spaces. Adhering to hands-on kinaesthetic activities such as lion dance could empower pre-schoolers' enthusiasm and reverence for cultural heritage. This study denotes that through kinaesthetic-cultural learning spaces, pre-schoolers could develop healthy learning development through cultural games.

4.2 The Preferences for Experiential-Cultural Space Design

This study recommends that owners provide pre-schoolers with the best learning environments to encourage cultural and experiential learning when building a preschool. Experiential-cultural learning spaces programming could potentially solve conventional preschool learning spaces. When experiential-cultural spatial design fits preschool needs, it enhances pre-schoolers' excitement to learn and go to school. At the same time, it would encourage spontaneity, curiosity, and communication that could stimulate pre-schoolers' five sensory adventures and fun within their Environment. Through experiential-cultural spatial design, pre-schoolers' children will be analytical, evolve, and have high morale. The injection of cultural values and symbols in the spatial design could stimulate children’s cultural learning interests as part of their early education.

4.3 Recommendation for Cultural-Kinaesthetic Spatial Design Requirements

Kinaesthetic learning is frequently employed in educational spatial design, particularly museums and cultural preservation settings, to cater to wider educational initiatives. In the preschool context, this education space setting could aid pre-schoolers in learning using their five senses. Visual art, for example, when injected into kinaesthetic learning, could receive cultural aesthetics, emotion, and recognition, then turn into joyous and experiential activities. This sensory would boost pre-schoolers' self-confidence and stimulate fun experiences during school duration. Therefore, constantly strengthening the kindergarten experiential-cultural spatial design can promote young children's physical and mental health and long-term physical exercise. The following six points are experiential-cultural spatial design requirements:

1) A recirculation feature ought to be included. Pre-schoolers can chase one another around the playground in a manner akin to the handkerchief game. The game should have a migratory trajectory.
2) The safety features of the experiential, cultural game track should be adaptable and changeable.
3) iconic spatial symbols for multi-sensory experiences should be included.

4) Pre-schoolers should be able to experience vertigo thanks to this spatial construction. For instance, by incorporating several cultural symbols or aspects into the design of a "pathway" or "labyrinth," a "cultural labyrinth" can be produced. It provides pre-schoolers with the fortitude and motivation to conquer obstacles.
5) Modular and adaptable space: the area must be able to change to accommodate various cultural activities, including performances, exhibitions, and festivals.
6) The materials are secure and safe for the Environment.

5.0 CONCLUSIONS

This paper seeks to answer the question of what the best healthy spatial design requirements for preschool children in China are. The kinaesthetic-cultural spatial design requirements are recommended in preschool's spatial design to enhance their cultural cognition, happiness, and learning stimulation. The injection of cultural game characteristics in preschool learning space through the five senses could critically affect their healthy learning environment. Free play spaces, cultural games equipment such as lion dance, and contextual culture could influence children's education and pedagogy. In this way, it could boost healthy and joyous learning in school environments. This study also proposed that combining multiple forms of cultural games and environmental settings, such as the experiential-cultural spatial design (ECSD) and kinaesthetic learning in school spaces, could strengthen children's physical fitness and give happy feelings to the children. This study identified that cultural games such as lion dance could be instilled in the school spaces by integrating China's contextual education in preschool. This study recommends that the ECSD requirements aid China's education ministry and designers in successfully designing the best contextual preschool education spatial design for preschool children and promoting children's happiness in school.

ACKNOWLEDGMENTS

This study is part of a PhD degree by the first author in the field of Integrated Design Studies at the Faculty of Design and Architecture, Universiti Putra Malaysia.

REFERENCES

Abarca-Gómez, L., Abdeen, Z. A., Hamid, Z. A., Abu-Rmeileh, N. M., Acosta-Cazares, B., Acuin, C., ... & Cho, Y. (2017). Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128· 9 million children, adolescents, and adults. *The Lancet*, *390*(10113), 2627-2642.

Agustia, R. D., & Arifin, I. N. (2018, August). Implementation of visual, auditory, kinaesthetic, and tactile model learning systems to help mild retarded children in alphabetical and numeric learning. *In IOP Conference Series: Materials Science and Engineering* (Vol. 407, No. 1, p. 012009). IOP Publishing.

Ayers, J., (1972). Improving academic scores through sensory integration. *Journal of Learning Disabilities.* 5, 336–34.

Breathnach, H., Danby, S., & O'Gorman, L. (2017). 'Are you working or playing?'Investigating young children's perspectives of classroom activities. *International Journal of Early Years Education*, *25*(4), 439–454.

Bull, F. C., Al-Ansari, S. S., Biddle, S., Borodulin, K., Buman, M. P., Cardon, G., ... & Willumsen, J. F. (2020). World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *British journal of sports medicine*, *54*(24), 1451–1462.

Bouchard, C., Blair, S. N., & Haskell, W. L. (2012). *Physical activity and health*. Human Kinetics.

Caillois, R. (2001). *Man, play, and games*—University of Illinois Press.

Carson, V., Lee, E. Y., Hewitt, L., Jennings, C., Hunter, S., Kuzik, N., ... & Tremblay, M. S. (2017). Systematic review of the relationships between physical activity and health indicators in the early years (0-4 years). *BMC*

Public Health, *17*(5), 33–63.
Chen, Q. J.. (2017). *Chinese Folklore*. BEIJING BOOK CO. INC.
Choy, G. (2017). Chinese culture in early educational environments. *Early childhood education in Chinese societies*, pp. 31–52.
Click, E. (2011). Contextual education. *The Wiley Blackwell Companion to Practical Theology*, 347-356.
Costantini, S. (2022). The" Labyrinth" Archetype as Educational Scenario in Preschool Age. *INTERNATIONAL JOURNAL OF LEARNING AND TEACHING*, *8*, 53-58.
Cote, A. T., Harris, K. C., Panagiotopoulos, C., Sandor, G. G., & Devlin, A. M. (2013). Childhood obesity and cardiovascular dysfunction. *Journal of the American College of Cardiology*, *62*(15), 1309–1319.
Council, E. C. A. (2003). Preschool Learning Experiences.
Daniels, S. R., Arnett, D. K., Eckel, R. H., Gidding, S. S., Hayman, L. L., Kumanyika, S., ... & Williams, C. L. (2005). Overweight in children and adolescents: pathophysiology, consequences, prevention, and treatment. *Circulation*, *111*(15), 1999-2012.
Dudek, M. (2005). *Children's spaces*. Routledge.
Fitzpatrick, P., & Flynn, N. (2010). Dynamic (kinaesthetic) touch perception in preschool children. *Ecological Psychology*, *22*(2), 89–118.
Fu, Xiaolan, Kan Zhang, Xuefeng Chen, & Zhiyan Chen. 2011 A new species of the genus Lepidoptera (Lepidoptera, Lepidoptera, Lepidoptera). (2023). China National Mental Health Development Report (2021-2022). *Mental Health Blue Book*.
Gardner, H., & Hatch, T. (1989). Educational implications of the theory of multiple intelligences. *Educational researcher, 18*(8), 4–10.
Gass, M. A., Gillis, H. L., & Russell, K. C. (2012). Adventure therapy: Theory, practice, & research.
Ghafar, M.A. and Ibrahim, R. The Malaysian AEC Professionals Work Culture Could Improve Organisational Team Productivity during Industrialized Project Delivery. Pertanika Social Science & Humanities 3 (26), 1-15
Gomez, M. L., Walker, A. B., & Page, M. L. (2000). Personal experience as a guide to teaching. *Teaching and teacher education*, *16*(7), 731–747.
Grønbæk, K., Iversen, O. S., Kortbek, K. J., Nielsen, K. R., & Aagaard, L. (2007, September). Interactive floor support for kinaesthetic interaction in children learning environments. In *IFIP Conference on Human-Computer Interaction* (pp. 361-375). Berlin, Heidelberg: Springer Berlin Heidelberg.
Guan, H., Zhang, Z., Wang, B., Okely, A. D., Tong, M., Wu, J., & Zhang, T. (2020). Proportion of kindergarten children meeting the WHO guidelines on physical activity, sedentary behaviour and sleep and associations with adiposity in urban Beijing. *BMC pediatrics*, *pp. 20*, 1–9.
Guan Hongyan, Zhao Xing, Qu Sha, Wu Jianxin, Yang Yufeng, Guo Jianjun, ... & Luo, Dongmei. (2020). Exercise guidelines for preschool children (3-6 years old). *Chinese Journal of Child Health*, *28*(6), 714-720.
Hanafiah, H., Nurapriani, R., & Gaffar, M. A. (2018, November). Game Model Based on Cultural Values Approach in Developing Interpersonal and Kinaesthetic Intelligences in Early Childhood. In *4th International Conference on Early Childhood Education*. *Semarang Early Childhood Research and Education Talks (SECRET 2018)* (pp. 1-7). Atlantis Press.
Hao, Xiaocen, Jun He, & Guan, Wenlu. 2011 A new species of the genus Pseudourostyla (Hymenoptera, Braconidae) from China. (2021). Characterisation and construction of early childhood sports environment in China. *Journal of Beijing Sport University*, 44(9).
Hatira, A., & Sarac, M. (2024). Touch to Learn: A Review of Haptic Technology's Impact on Skill Development and Enhancing Learning Abilities for Children. *Advanced Intelligent Systems*, 2300731.
Hofstede, G. (2001). *Culture's consequences: Comparing values, behaviors, institutions andorganizations across nations*. Sage publications.
Hu, B. Y., Guo, Y., Wang, S., & Vitiello, V. E. (2021). The associations between teacher-child relationships and academic skills: A longitudinal study among Chinese preschool children. *Contemporary Educational Psychology*, *67*, 102020.
Ibrahim, R. (2011). Demystifying the arduous doctoral journey: The eagle vision of a research proposal. *Electronic Journal of Business Research Methods*, *9*(2), pp130-140.
Ibrahim, R., & Mustafa Kamal, R. (2018). Templates for Thinking. Unpublished Literary. *Copyright MYIPO LY2018002437*, *260*.
Ingold, T. (2002). Culture and the Perception of the Environment. In *Bush base, forest farm* (pp. 38–56). Routledge.
Ji, C. Y., Sun, J. L., & Chen, T. J. (2004). Dynamic analysis on the prevalence of obesity and overweight school-age children and adolescents in recent 15 years in China. *Zhonghua liu xing bing xue za zhi= Zhonghua liuxingbingxue zazhi*, *25*(2), 103-108.

Ji, X., & Sirisuk, M. (2024). Lion head colorful tie-dye at Foshan city, Guangdong Province: National representative and revitalising self-identity in the process of chinesenization. *Multidisciplinary Science Journal*, *6*(11).

Kenya Hara. (2007). Design in design. Beijing Clothing Textile, (10), pp. 152–152.

Kleppe, R. (2018). Affordances for 1-to 3-year-olds' risky play in Early Childhood Education and Care. *Journal of Early Childhood Research*, *16*(3), 258–275.

Kohl, H. W., Craig, C. L., Lambert, E. V., Inoue, S., Alkandari, J. R., Leetongin, G., & Kahlmeier, S. (2012). The pandemic of physical inactivity: global action for public health. *The Lancet*, *380*(9838), 294-305.

Kovač, S., Imamović-Turković, D., & Merdan, M. (2019). THE PLAYGAME ROLE IN PREVENTION OF PROPER POSTURE IN ELEMENTARY SCHOOL STUDENTS. *Homo Sporticus*, (2).

Kwon, J., & Iedema, A. (2022). Body and the senses in spatial experience: The implications of kinaesthetic and synesthetic perceptions for design thinking. *Frontiers in Psychology*, *13*, 864009.

Lam, W. M., & Ripman, C. H. (1977). *Perception and lighting as formgivers for architecture* (pp. 10-12). New York: McGraw-Hill.

Lengel, T., & Kuczala, M. (Eds.). (2010). *The kinaesthetic classroom*: *Teaching and learning through movement*. Corwin Press.

Lercher, P., Evans, G. W., Meis, M., & Kofler, W. W. (2002). Ambient neighbourhood noise and children's mental health. *Occupational and environmental medicine*, *59*(6), 380-386.

Li, S., Jiang, Q., & Deng, C. (2022). The Development and Validation of an Outdoor Free Play Scale for Preschool Children. *International Journal of Environmental Research and Public Health*, *20*(1), 350.

Li, Jimei. (2001). Understanding of some basic ideas in the "Guideline for Kindergarten Education". *Research on Preschool Education*, (6), pp. 6–9.

Li Li. (2019). Plant planting design of children's activity area based on five senses - an example of planting design of children's activity area in Peace Park—Flora, p. 14.

Li, S. (2022). Preschool education students' understanding of children's picture books. *Wireless Communications and Mobile Computing, 2022*.

Lin Yan. (2014). The Role and Application of Games in Rehabilitation Theme Classes for Young Children with Hearing Impairment[J]. *Journal of Jiangsu Normal University* (*Education Science Edition*), (S2): pp. 87–89.

Lipnowski, S., LeBlanc, C. M., Canadian Paediatric Society, & Healthy Active Living and Sports Medicine Committee. (2012). Healthy active living: Physical activity guidelines for children and adolescents. *Paediatrics & child health*, *17*(4), 209–210.

Lloyd, L. J., Langley-Evans, S. C., & McMullen, S. (2010). Childhood obesity and adult cardiovascular disease risk: a systematic review. *International journal of obesity*, *34*(1), 18–28.

Long, M. H., & Liang, H. (2011). Characteristics of folk games and their value in kindergarten teaching. Education: Research on Higher Education, (6), 202-203.

Lubomira, D. (2004). Environmental education at preschool. *International Research in Geographical & Environmental Education*, *13*(3), 258–263.

Ma, H., Su, H., & Cui, J. (2022). Characterisation of soundscape perception of preschool children. *Building and Environment*, *p. 214*, 108921.

Masiran, R., Ibrahim, N., Awang, H., & Lim, P. Y. (2020). Improving multicultural parenting program for children with emotional and behavioural problems: an integrated review. *Asian journal of psychiatry*, 51, 101851.

Maxwell, L. E. (2018). The role of the physical Environment in education. In *Environmental Psychology and Human Well-Being* (pp. 135–166). Academic Press.

Maxwell, L. E., & Evans, G. W. (2000). The effects of noise on preschool children's pre-reading skills. *Journal of Environmental Psychology*, *20*(1), 91–97.

Mei, S. D., & Luen, L. C. (2023). Effect of Kindergarten Environment Creation Quality on Children's Health, Language, Social, Science and Art. *International Journal of Academic Research in Progressive Education and Development*, *12*(*2*), 187–219.

McPhee, P. G., Singh, S., & Morrison, K. M. (2020). Childhood obesity and cardiovascular disease risk: Working toward solutions. *Canadian Journal of Cardiology*, *36*(9), 1352–1361.

Mok, Xiaochao, & Li, Shanze. (2006). The use of folk game resources in kindergarten activities and its strategies. *Research on Preschool Education*, (9), 26-29.

Mou, Yingxue, & Yingxue Mou. (2003). The characteristics of early childhood education changed in China in the 1950s. Journal of East China Normal University (Education Science Edition), 21(2), 61.

Olabi, A. (2012). *Fine motor activities*. Strategic Book Publishing

Oudgenoeg-Paz, O., Boom, J., Volman, M. C. J., & Leseman, P. P. (2016). Development of exploration of spatial-relational object properties in the second and third years of life. *Journal of Experimental Child*

Psychology, *146*, 137-155.
Pan, Y., Wang, X., & Li, L. (2018). Early childhood education and development in China. *International handbook of early childhood education*, 599-622.
Piscitelli, B., & Penfold, L. (2015). Child-centred practice in museums: Experiential learning through creative play at the Ipswich Art Gallery. *Curator: The Museum Journal*, *58*(3), 263-280.
Pui-Wah, D. C., Reunamo, J., Cooper, P., Liu, K., & Vong, K. I. P. (2015). Children's agentive orientations in play-based and academically focused preschools in Hong Kong. *Early Child Development and Care*, *185*(11-12), 1828-1844.
Qian, Huang, & Shih-Shi Li. (2021). Exploration of campus landscape optimisation based on the five senses. *Engineering Technology Research*, 3(8), 172-174.
Rousseau, D. M., Manning, J., & Denyer, D. (2008). 11 Evidence in management and organisational science: assembling the field's full weight of scientific knowledge through syntheses. *Academy of Management Annals*, 2(1), 475–515.
Sivilotti, P. A., & Pike, S. M. (2007, March). The suitability of kinaesthetic learning activities for teaching distributed algorithms. In *Proceedings of the 38th SIGCSE technical symposium on Computer Science Education* (pp. 362-366).
Singh, R., Gupta, N., & Singh, G. (2016). Learning style and teaching methodology preferences of dental students. *Journal of the Anatomical Society of India*, *65*(2), 152–155.
Soden, Z. (2020). Daily living skills. In *Educating young children with additional needs* (pp. 117–139). Routledge.
Storli, R., & Hagen, T. L. (2010). Affordances in outdoor environments and children's physically active play in preschool. *European Early Childhood Education Research Journal*, *18*(4), 445-456.
Sutton-Smith, B. (1997). The ambiguity of play: rhetorics of fate. *The Performance Studies* Reader, pp. 132–138.
Tan, C. T., & Rao, N. (2017). How do children learn? Beliefs and practices reported by kindergarten teachers in Singapore. *Asia-Pacific Journal of Research in Early Childhood Education*, *11*(3), 81-112.
Tashpulatov, F. A., & Shermatov, G. K. (2021). Place and role of physical education in preschool children's general education system. *International Journal of Development and Public Policy*, *1*(5), 77–80.
Tarman, I., & Tarman, B. (2011). DEVELOPING EFFECTIVE MULTICULTURAL PRACTICES: A CASE STUDY OF EXPLORING A TEACHER'S UNDERSTANDING AND PRACTICES. *Journal of International Social Research*, *4*(17).
Telama, R., Yang, X., Leskinen, E., Kankaanpää, A., Hirvensalo, M., Tammelin, T., ... & Raitakari, O. T. (2014). Tracking of physical activity from early childhood through youth into adulthood. *Medicine & Science in Sports & Exercise*, *46*(5), 955-962.
Templier, M., & Paré, G. (2015). A framework for guiding and evaluating literature reviews. *Communications of the Association for Information Systems*, *37*(1), 6.
Terrón-Pérez, M., Molina-García, J., Martínez-Bello, V. E., & Queralt, A. (2021). A systematic review of the relationship between the physical Environment and physical activity levels in preschool children. *Current Environmental Health Reports*, *8*(2), 177-195.
Thompson, C. M. (2009). Mira! Looking, listening, and lingering in research with children. *Visual arts research*, *35*(1), 24–34.
Umer, A., Kelley, G. A., Cottrell, L. E., Giacobbi, P., Innes, K. E., & Lilly, C. L. (2017). Childhood obesity and adult cardiovascular disease risk factors: a systematic review with meta-analysis. *BMC Public Health*, *17*(1), 1–24.
Umo, U. A., Anthony, N. N., & Abang, K. B. (2019). Psychology of leisure and creative learning for the Nigerian child. *Interdisciplinary Journal of Science Education*, *1*(1), 36-44.
Uttal, D. H. (2017). Spatial symbols and thought: Cross-cultural, developmental, and historical perspectives on map use and spatial cognition. In *Symbol use and symbolic representation* (pp. 3–24). Psychology Press.
van Liempd, H. I. M., Oudgenoeg-Paz, O., Fukkink, R. G., & Leseman, P. P. (2018). Young children's exploration of the indoor playroom space in center-based childcare. *Early Childhood Research Quarterly*, *43*, 33-41.
Varman, S. D., Cliff, D. P., Jones, R. A., Hammersley, M. L., Zhang, Z., Charlton, K., & Kelly, B. (2021). Experiential learning interventions and healthy eating outcomes in children: a systematic literature review— *International Journal of Environmental Research and Public Health*, *18*(20), 10824.
Wang, C., & Qin, H. (2017). Research on plant configuration of children's activity space based on five senses. *Journal of Southwest Normal University: Natural Science Edition*, 42(4), 76–80.
Wang, X., Zhen, G., Qiu, Z., & Zhang, M. (2024). We promote the Lion Dance as an Intangible Cultural Heritage via Education in Lingnan, China. In Cultural Tourism in the Asia Pacific: Heritage, *City and Rural Hospitality* (pp. 165-182). Cham: Springer Nature Switzerland.
Wehrwein, E. A., Lujan, H. L., & DiCarlo, S. E. (2007). Gender differences in learning style preferences among

undergraduate physiology students. *Advances in physiology education*.
Williams, H. G., Pfeiffer, K. A., O'Neill, J. R., Dowda, M., McIver, K. L., Brown, W. H., & Pate, R. R. (2008). Motor skill performance and physical activity in preschool children. *Obesity, 16*(6), 1421–1426.
Wisneski, D. B., & Reifel, S. (2012). The place of play in early childhood curriculum. *Curriculum in early childhood education: Re-examined, rediscovered, renewed*, 175-187.
Woodman, G. (2010). *Cultural Shock-Taiwan: Cow Mentality, Rubber Slipper Fashion in BinLang Country*. Xlibris Corporation.
Xiao, Y., & Watson, M. (2019). Guidance on conducting a systematic literature review. *Journal of planning education and research*, *39*(1), 93–112.
Xu, S. G., Zeng, Z. Q., & Chen, Y. H. (2017). Research the Function of the Dragon and Lion Dance under the Background of the National Fitness. *DEStech Transactions on Social Science Education and Human Science DOI*, 10.
Yahya, W., & Noor, N. (2015). Decision support system for learning disabilities children in detecting visual-auditory-kinaesthetic learning style. In *The 7th International Conference on Information Technology* (pp. 667-671).
Yap, J. (2017). *The Art of Lion Dance* (Vol. 1). Joey Yap Research Group.
Yıldız, D., Fidan, U., Yıldız, M., Er, B., Ocak, G., Güngör, F., ... & Akyildiz, Z. (2024). Development and evaluation of an image processing-based kinaesthetic learning system. *Applied Sciences*, *14*(5), 2186.
Zhao, W. . (2018). Prevention and control of childhood overweight and obesity is a very urgent task. *Chinese Journal of Epidemiology*, *39*(6), 705–706.
Zhou, L. (2021, August). Research on Introducing the Five Senses of "Vision, Hearing, Smell, Taste, and Touch" into the Design of Picture Books for Autistic Children. In *7th International Conference on Arts, Design and Contemporary Education (ICADCE 2021)* (pp. 542–548). Atlantis Press.
Zhuang Bi, Ren Qi, Li Menning, & Jing Pengfei. (2015). Reflections on Early Childhood Physical Activity and Its Content System. *Journal of Physical Education/Tiyu Xuekan*, *22*(6).

JOURNAL OF ARCHITECTURE, PLANNING & CONSTRUCTION MANAGEMENT
Volume 14 Issue 2, 2024 E-ISSN: 2462-2222 ISSN: 2231-9514

REVITALIZING KELANTAN MALAY TRADITIONAL ARCHITECTURE: THE ADAPTATION OF MALAY TRADITIONAL ARCHITECTURE DESIGN FEATURES IN KELANTAN TO MODERN CONTEMPORARY ARCHITECTURAL SCHEME

Received: 09 Sep 2024 | Accepted: 07 Nov 2024 | Available Online: 07 Dec 2024
DOI: 10.31436/japcm.v14i2.925

Nur Shafiqah binti Abdul Razak[1], Azmal bin Sabil[2*]

[1] *Faculty of Civil Engineering, University Tun Hussein Onn Malaysia,* af210016@student.uthm.edu.my

[2] *Faculty of Civil and Engineering, University Tun Hussein Onn Malaysia,* azmal@uthm.edu.my

Corresponding author:* ***Azmal Bin Sabil*
Corresponding author's email: azmal@uthm.edu.my

ABSTRACT

The highlighted issue in reforming traditional Malaysian architecture into modern contemporary architectural design is maintaining the cultural and historical integrity of traditional Malaysian architecture elements while adapting them to meet contemporary architecture's functional, aesthetic, and sustainability demands. This paper examines the possibility of adapting traditional Kelantanese Malay architectural elements into modern contemporary architectural design, emphasizing the preservation of key features that reflect the region's rich cultural and historical identity. Distinctive components such as entrance gates (*pintu gerbang*), decorative wall panels (*dinding janda berhias*), major pillars (*tiang seri*), and handcrafted details are highlighted, alongside the symbolic and aesthetic significance of *ekor itik* (duck tail end gables), *kayu tunjuk langit* (sky-pointing beams) and *buah butung* (beautiful finials). In terms of sustainable design approach, the features of *tebuk tembus* (pierced carvings) enhance ventilation and light penetration. The study's objectives involve documenting notable examples of traditional Kelantanese buildings, analysing their design features, and proposing a framework for incorporating these elements into modern architecture. Methodologically, the research employs case studies of selected buildings to examine their architectural features, spatial layouts, material choices, and cultural significance. The findings suggest that architectural elements like pierced carvings (*tebuk tembus*), decorative panels, and finials (*buah butung*) can seamlessly integrate into modern contemporary architectural design. Ultimately, the paper advocates revitalizing Kelantanese Malay architecture through a balanced synthesis of tradition and modernity.

Keywords: Traditional Kelantanese Malay architecture, modern contemporary architectural design, modern tradition.

1.0 INTRODUCTION

Malaysia's cultural legacy is closely linked to its traditional architecture, of which Kelantan is a prime example. Kelantanese Malay architecture is well-known for its rich cultural past. It is distinguished by elaborate woodcarvings and unique roof forms, which have historically been essential to the state's cultural identity. However, the use of these traditional patterns has significantly decreased as a result of fast urbanization and modernization, undermining their cultural value (Sabil, 2020). Nowadays, wood is infrequently utilised in modern construction, despite its historical importance in the construction of Malay homes, mosques, and palaces. Furthermore, abandoning traditional stilt structures, which is a defining feature of Malay

architecture, poses difficulties because contemporary building techniques frequently ignore these important architectural components (Abidin et. al., 2017).

Contemporary buildings in Kelantan increasingly diverge from the sustainable and culturally significant features of traditional Malay houses. The absence of architectural elements such as passive ventilation systems and intricate wood carvings diminishes the cultural depth and historical continuity that these structures once embodied (Ismail et. al., 2015). The preference for modern construction techniques further distances contemporary buildings from their cultural roots by neglecting traditional materials and design principles (Kinosyan & Bashirova, 2021). The decline in traditional Malay architectural elements not only affects the visual appeal of Kelantan but also undermines its cultural resilience. The abandonment of sustainable design characteristics found in vernacular Malay houses contributes to a disconnect from the past and a weakening of cultural sustainability (Zain et al., 2023). As a result, the unique identity and historical significance of traditional Malay architecture are increasingly overshadowed by modern trends. (Harun et. al., 2017)

The decline in traditional Malay architectural styles in contemporary Kelantan buildings signifies a loss of cultural identity and heritage. The neglect of traditional design elements and materials not only impacts the visual landscape but also diminishes the cultural resilience and historical continuity of Malay architecture. Efforts to reintroduce traditional architectural elements into modern constructions are essential to preserving Kelantan's rich cultural heritage and maintaining the unique identity of the Malay community.

2.0 LITERATURE REVIEW

2.1 Kelantanese Malay Traditional Architecture

Kelantan Malay traditional architecture is a unique and distinct form of architectural design that reflects the cultural and historical identity of the Kelantan Malay community. The architectural elements of traditional Malay Kelantan architecture are characterized by intricate wood carvings, decorative motifs, and specific spatial structures that are integral to the identity of the Malay Muslims in Kelantan (Noor & Nasir, 2019; Othman & Shuaib, 2013). The wood carvings and decorative elements play a significant role in signifying the characteristics and identity of Malay traditional architecture, contributing to the aesthetic and cultural values of the traditional Malay houses in Kelantan (Wahid et al., 2021; Said, 2012). Furthermore, the spatial structure found in traditional Malay houses in Kelantan is considered an important component in the architectural identity of the Malay Muslims (Othman & Shuaib, 2013).

The architectural significance of Kelantan is further exemplified by the presence of traditional mosques, such as the Kampung Laut Mosque, which is considered the oldest existing example of traditional Malay mosque architecture, reflecting the historical and cultural heritage of the region (Zekrgoo, 2017). Additionally, the implementation of Malay traditional architectural elements in mosques, such as Masjid Kampung Laut, showcases the preservation of the traditional Malay architectural identity in religious structures (Khalit, 2023).

The distinctiveness of Kelantan Malay traditional architecture is also influenced by the genetic and historical background of the Kelantan Malay population. Genetic studies have revealed

that the Melayu Kelantan forms a distinct genetic group, indicating their genetic differentiation from other Malay sub-ethnic groups and reflecting their unique ancestral history and geographical location in the north-eastern region of Peninsular Malaysia (Hatin et al., 2011; Juhari et al., 2014; Hatin et al., 2014). This historical and genetic divergence has contributed to the development of a unique architectural identity that is specific to the Kelantan Malay community.

In general, Kelantan Malay traditional architecture is characterized by its intricate wood carvings, decorative motifs, spatial structures, and the preservation of traditional architectural elements in religious structures, as shown in Fig. 1. The architectural identity of Kelantan Malay traditional houses and mosques reflects the cultural, historical, and genetic distinctiveness of the Kelantan Malay community, contributing to the rich tapestry of Malaysia's architectural heritage.

Fig. 1: An example of a traditional Kelantan Malay house, characterized by its extensive use of decorative ornamentation, serves as a significant representation of cultural heritage preservation.
(Source: Bernama, https://www.bernama.com/bm/am/news.php?id=2076562)

2.2 Key Characteristics of Kelantan Malay Traditional Architecture

The key characteristics of Kelantanese Malay traditional architecture encompass several distinctive elements that reflect the cultural and historical identity of the region. These characteristics are deeply rooted in the architectural heritage of the Kelantan Malay community and are integral to the traditional Malay houses and settlements in the region. The traditional Malay houses are characterized by intricate wood carvings, decorative motifs,

and specific spatial structures, which play a significant role in signifying the identity of Malay traditional architecture (Toe & Kubota, 2013; Hassin & Misni, 2019). Additionally, the traditional Malay fortification system is a notable characteristic that reflects the historical significance of the architectural design in Kelantan (Jaffar & Kunapalan, 2021).

Furthermore, the architectural design of traditional Malay houses in Kelantan incorporates passive thermal design strategies, such as natural ventilation and low thermal capacity materials, to ensure thermal comfort and sustainability (Hassin & Misni, 2019; Hassin & Misni, 2021; Hassin & Misni, 2022;). The close link between the vernacular aspect of old Malay architecture and its affinity with nature and the community further emphasizes the unique characteristics of Kelantanese Malay traditional architecture (Jaffar et al., 2020).

The study aims to explore and identify the key elements that define Kelantan traditional architecture, focusing on various distinctive features and ornamental details that shape the architectural identity of the region. Specific components such as the *pintu gerbang* (entrance gate), *dinding janda berhias* (decorative wall panels), *tiang seri* (main pillar), handcrafted ornamentation, *kayu tunjuk langit* (sky-pointing beams), *buah butung* (ornamental finials), *tebuk tembus* (pierced carvings), *pemelah & tebar layar* (gables and vented screens), and *ekor itik* (duck tail end gables) will be analysed for their architectural significance and cultural relevance (Noor & Nasir, 2019). Through this comprehensive examination, the research aims to provide a deeper understanding of the rich architectural heritage of Kelantan and the elements that make it unique.

The key characteristics of Kelantanese Malay traditional architecture encompass intricate wood carvings, decorative motifs, spatial structures, passive thermal design strategies, and the integration of Islamic and cultural elements. These features reflect the rich architectural heritage and cultural identity of the Kelantan Malay community, contributing to the unique and distinctive architectural landscape of the region. The study seeks to shed light on these elements to preserve and promote the traditional architectural legacy of Kelantan for future generations.

2.3 Approaches in Adapting Kelantanese Malay Traditional Architecture into Contemporary Modern Design

To propose a design framework for modern Malay Kelantan architecture, it is essential to integrate traditional architectural elements with modern design principles, sustainability, and cultural preservation. The framework should aim to blend traditional and contemporary architectural features harmoniously, ensuring the preservation of cultural identity while meeting the functional and environmental needs of modern society.

Malay architecture, distinguished by its unique design features, reflects the cultural, social, and environmental contexts of the Malay community. The proposed design framework should prioritize the incorporation of these traditional elements to create a seamless blend of the old and the new. Architectural styles such as the Rumah Tiang Dua Belas exemplify structures that are deeply rooted in local culture and the surrounding environment. The elements, such as intricate wood carvings and motifs, enhance the aesthetic appeal while also providing functional benefits, such as improved indoor climate conditions (Ismail et al., 2015).

The preservation of these elements is essential, as they represent the artistic heritage of the Malay community and contribute significantly to the overall architectural identity of Kelantan. Drawing inspiration from the thermal comfort and passive cooling techniques observed in traditional Malay houses, as studied by Toe & Kubota (2013), the framework can incorporate passive design strategies to enhance indoor thermal comfort in modern architectural designs, especially in Kelantan's tropical climate.

From the perspective of Islamic principles adaptation, the research conducted by Yusof et al. (2021) offers significant insights into the adaptation of Islamic principles within traditional Malay houses. These findings clarify the distinct architectural features and design elements that embody Islamic values, thereby fostering a connection between cultural heritage and spiritual beliefs. Such knowledge can be instrumental in the integration of Islamic elements into modern architectural frameworks, particularly concerning the design of mosques and public buildings in Kelantan. By leveraging these traditional principles, contemporary structures can successfully cultivate a sense of identity and community while paying homage to the region’s rich Islamic architectural heritage.

In the context of architectural design for the Malay community in Kelantan, it is essential to consider the socio-cultural and religious needs of the local population. Architecture in a region transcends mere aesthetic preferences; it is deeply intertwined with the cultural identity, beliefs, and practices of its inhabitants. This is particularly notable within the Malay community, where traditional architecture serves as a representation of their cultural heritage and social values. The incorporation of traditional Malay architectural elements is vital for creating spaces that resonate with local identity. Hidayat (2011) highlights the necessity for traditional architecture to adapt to contemporary needs while preserving its cultural significance, suggesting that a balance between modernity and tradition is crucial for sustainable urban development. This view is supported by Faisal et al. (2021), who assert that architecture should reflect society's way of life, beliefs, and philosophies, thereby safeguarding the unique cultural components of the Malay community.

In essence, the proposed design framework for modern Malay Kelantan architecture should incorporate traditional architectural elements, passive design strategies, Islamic principles, conservation efforts, and cultural preservation. This approach aims to create a sustainable, culturally sensitive, and functional architectural approach that reflects the rich heritage of Kelantan.

Table 1 presents the key characteristics identified through a comprehensive review of the literature on traditional Kelantanese Malay architecture. Numerous frequently mentioned components are highlighted in the table, showcasing the salient features of this architectural style and emphasizing their significance. The most commonly cited characteristics, such as timber material, Kayu Tunjuk Langit (Sky-Pointing Timber), and Pemeleh, are noted six times, underscoring their crucial roles in durability, heritage identity, and decoration. Additionally, features like Ekor Itik, Handcraft Ornamentation, Dinding Janda Berhias, Pintu Gerbang, and Buah Butung, mentioned five and four times respectively, illustrate the complex workmanship and visual appeal that are essential to these buildings. The Tebar Layar (Gable End), referenced three times, further enhances the ornamental and functional aspects of the

structures. Lastly, the structural importance of the Tiang Seri (Main Pillar) is acknowledged, despite its less frequent mention.

Table 1: Key Characteristics of Kelantan Malay Traditional Architecture

Authors	Traditional Elements								Functional Features		Materials
	Ekor Itik	Kayu Tunjuk Langit	Pintu Gerbang	Dinding janda Berhias	Tiang Seri	Handcraft Ornamentation	Pemeleh	Tebar Layar	Tebuk Tembus	Buah Butung	Timber Material
Che Mood, N. A., & Ramli, R. R. (2022)	/	/	/			/	/	/		/	/
Karim, N. (2021)						/			/		/
Nawayai, S. S. M., Denan, Z., & Abdul Majid, N. H. (2020).		/	/	/		/	/		/		/
Sojak, S. D. M. and Utaberta, N. (2013)	/	/			/	/	/			/	/
Shuaib, A. A., and Olalere, F. E., (2013)	/	/	/	/			/	/	/	/	/
Abdullah, A., Wahid, J., Nizam, W., Khairuddin, M., Luqman, I., & Hasim, A. (2021).	/	/	/	/			/	/	/	/	/
Noor, N. M., & Nasir, M. R. M. (2019).	/	/		/			/				
Total	**5**	**6**	**4**	**4**	**1**	**4**	**6**	**3**	**4**	**4**	**6**

In light of the components outlined in this table, a comprehensive case study is planned. The focus will be on exploring the applicability and significance of key elements such as Kayu Tunjuk Langit (Sky-Pointing Timber), Timber Chengal Woods, Pemeleh (Roof Ridge), and Handcrafted Ornamentation within the context of Kelantanese Malay traditional architecture. The analysis will examine the structural and aesthetic roles of features like Ekor Itik (Duck Tail), Pintu Gerbang (Gateway), Tebar Layar (Gable End), Dinding Janda Berhias (Decorative Widow's Wall), and Tiang Seri (Main Pillar), drawing on numerous references from the literature. This in-depth examination aims to deepen the understanding of how these components interact to shape and preserve the architectural heritage of Kelantan.

3.0 METHODOLOGY

This research explores the integration of traditional Kelantanese Malay architectural elements into contemporary designs by examining key traditional buildings in Kelantan, particularly two mosques constructed after 2010: Masjid Mukim Sabak and Masjid Ar-Rahman Pulau Gajah. The evaluation models established from the review (Table 1) were used to evaluate both mosques. Masjid Mukim Sabak, as analysed by Noor and Nasir (2019), exemplifies incorporating traditional Malay architecture into modern design, reflecting the cultural heritage of Kelantan. In contrast, Masjid Ar-Rahman Pulau Gajah, studied by Bahauddin (2021) and Zakaria (2022), emphasizes architectural simplicity influenced by Hindu-Buddhist syncretism, illustrating how various cultural influences shape modern mosque design in the region.

By examining these mosques, researchers can gain valuable insights into how traditional elements and cultural contexts are woven into contemporary mosque construction in Kelantan. These case studies showcase diverse architectural approaches and contribute to a richer understanding of contemporary mosque design in the area.

3.1 Masjid Mukim Sabak

The Mukim Sabak Mosque (Fig. 2), originally near Pantai Sabak in Kota Bharu and established in 1983, was relocated due to wave erosion. Construction began in 2011 and was completed in 2012. The mosque's design incorporates traditional architectural elements in the roof and utilizes new materials to enhance its appearance while maintaining traditional aesthetics. Featuring pillars and stages, it reflects traditional Kelantan Malay houses. The mosque serves as a model for future developments in the Kota Bharu 2020 Local Plan, demonstrating how traditional architectural elements can be integrated into contemporary structures. This successful incorporation of Malay traditional architecture showcases the potential for regional styles to influence modern developments and highlights the collaboration between designers and developers in preserving local heritage.

Fig. 2: Masjid Mukim Sabak Kota Bharu
(Source: Portal Masjid Malaysia, https://masjid.islam.gov.my/maklumatMasjidSurau?carian=&jenis=&negeri=&daerah=&masjidSurau=&page=390)

3.2 Masjid Ar-Rahman, Pulau Gajah

Masjid Ar-Rahman (Fig. 3) was constructed in Kampung Pulau Gajah, inspired by Masjid Kampung Laut; the mosque reflects a blend of Malay Kelantan, Nusantara, Turkish, Yemeni, and Moroccan architectural influences. The columns for the imam's prayer area are crafted from palm trees imported from the Middle East, with two entrance columns from Yemen. The Quranic drawings on the ceiling are from Turkey, and an Indonesian beduk is present in the courtyard. Intricate carvings, mostly by foreign woodcarvers from Jepara, Central Java, Indonesia, adorn the mosque's interior, exterior, and surroundings.

Fig. 3: Masjid Ar-Rahman, Pulau Gajah
(Source: Majlis Perbandaran Kota Bharu, https://info.mpkb.gov.my/masjid-ar-rahman/index.html)

4.0 ANALYSIS, RESULTS AND FINDING

This case study examined Masjid Mukim Sabak and Masjid Ar-Rahman, focusing on their integration of traditional Kelantanese Malay architectural elements within contemporary designs. A comprehensive table outlined key characteristics, including structural elements, decorative patterns, materials, and construction methods. By comparing these features, the study emphasized how both mosques preserved and adapted traditional principles, providing valuable insights into the fusion of cultural heritage with modern architecture.

Table 2: List of the Key Characteristics of Kelantan Malay Traditional Architecture in Masjid Ar-Rahman and Mukim Sabak

	Key Characteristics	Masjid Mukim Sabak	Masjid Ar-Rahman
1.	Pintu Gerbang (Gateway)		
2.	Dinding Janda Berhias		
3.	Tiang Seri	-	
4.	Handcraft Ornamentation	-	
5.	Tunjuk Langit	-	-

	Key Characteristics	Masjid Mukim Sabak	Masjid Ar-Rahman
6.	Buah Butung		
7.	Tebuk Tembus	-	
8.	Pemeleh		-
9.	Tebar Layar		-
10.	Ekor Itik	-	
11.	Timber as Building Material		

Based on Table 2, Masjid Mukim Sabak and Masjid Ar-Rahman present distinct architectural differences, emblematic of their varying degrees of integration with traditional Malay design principles. Masjid Ar-Rahman showcases an array of traditional features, including the *Tiang Seri*, Handcraft Ornamentation, *Tebuk Tembus*, *Pemeleh*, and *Tebar Layar*. These elements not only highlight traditional craftsmanship but also enhance aesthetic appeal and functional

qualities, such as improved ventilation. In contrast, Masjid Mukim Sabak is characterized by a more straightforward, modern design that lacks these specific features.

While both mosques incorporate a *Pintu Gerbang* as a common element, neither includes the *Tunjuk Langit* or *Ekor Itik*. The absence of these characteristics suggests a deliberate departure from architectural styles that emphasize vertical ornamentation or intricate roofline details. This trend towards a more grounded and horizontal design is apparent in both buildings, albeit with differing degrees of traditional embellishment.

Overall, the architecture of Masjid Ar-Rahman reflects a strong commitment to traditional Malay aesthetics, embracing decorative craftsmanship and cultural authenticity. Its use of timber further reinforces its connection to traditional materials, aligning with local environmental considerations. Conversely, Masjid Mukim Sabak's more streamlined design appears to prioritize functionality and modern efficiency over-elaborate decoration. This contrast underscores two distinct approaches to mosque architecture—one that preserves and showcases traditional elements and another that embraces a minimalist, potentially contemporary, design.

5.0 DISCUSSIONS

Masjid Mukim Sabak and Masjid Ar-Rahman exemplify the integration of Kelantanese Malay traditional architecture within contemporary contexts. These mosques serve not only as places of worship but also as significant architectural heritage sites that reflect the cultural richness of Kelantanese design. Each mosque features unique elements that blend tradition with modernity, demonstrating how historical architectural principles can be harmonized with contemporary needs.

Masjid Mukim Sabak is notable for its fusion of traditional Malay and contemporary design. Features such as the *Pintu Gerbang* and *Dinding Janda Berhias* highlight both aesthetic and functional aspects of traditional Malay architecture. The mosque employs modern construction methods, illustrating the coexistence of traditional and contemporary design while maintaining cultural relevance.

In contrast, Masjid Ar-Rahman emphasizes traditional timber materials and retains the ideals of traditional architecture characteristic in the smaller building components. This mosque showcases intricate wood carvings and incorporates passive thermal design strategies, signifying a commitment to sustainability. The use of natural materials reflects respect for traditional craftsmanship, ensuring the mosque is aesthetically appealing and environmentally harmonious.

Both mosques embody distinct strategies to represent Kelantanese Malay architectural traditions. The examination of these mosques contributed to the development of a framework for modernizing Kelantanese Malay architecture, encompassing Cultural Integration, Sustainable Practices, Architectural Education and Preservation, and Community Engagement. This approach fosters a sense of ownership and appreciation for traditional architectural values, ensuring their continuity in the modern era.

6.0 CONCLUSION

In conclusion, the study of Masjid Mukim Sabak and Masjid Ar-Rahman illustrates the potential for integrating traditional Kelantanese Malay architectural elements into modern designs. These mosques show how traditional principles can be adapted to meet contemporary needs while preserving cultural heritage. By analyzing significant Kelantanese traditional buildings and their design traits, a fundamental framework was developed to integrate the traditional characteristics of Kelantanese traditional architecture into modern contemporary design, emphasizing cultural integration, sustainable practices, and community engagement. The findings of this study provide essential guidance for future projects, promoting the creation of structures that honour the past while embracing innovation, thus fostering a deeper appreciation for Kelantan's architectural heritage.

ACKNOWLEDGMENTS

The authors would like to express their gratitude and appreciation to all those who contributed to this study, either directly or indirectly.

REFERENCES

Abdullah, A., Wahid, J., Nizam, W., Khairuddin, M., Luqman, I., & Hasim, A. (2021). Remembering the Malay settlement: A case of Rumah Tiang Dua Belas Kelantan. *BIMP-EAGA Journal for Sustainable Tourism Development*, 4, 1–9.

Abidin, N., Shahminan, R., & Ibrahim, F. (2017). Architectural influences of Istana Lama Seri Menanti, Negeri Sembilan. *Planning Malaysia*, 15(1). https://doi.org/10.21837/pmjournal.v15.i6.230

Bahauddin, A., & Zakaria, S. (2022). Cultural, architectural, 'sense of place' and sufistic beliefs in mosque tourism: Case study of Masjid Ar-Rahman, Pulau Gajah, Kelantan. *BIMP-EAGA Journal for Sustainable Tourism Development*, 11(1), 1–14. https://doi.org/10.51200/bimpeagajtsd.v11i1.3904

Che Mood, N. A., & Ramli, R. R. (2022). Adaptation of Malay traditional architecture on newly built mosques in Kelantan. *IOP Conference Series: Earth and Environmental Science*, 1067(1), 012026. https://doi.org/10.1088/1755-1315/1067/1/012026

Faisal, G., Najwa, N. F., Furqon, M. A., & Rozi, F. (2021). IT-architecture study literature research collaboration: Malay architecture context. *JOIV: International Journal on Informatics Visualization*, 5(3), 212. https://doi.org/10.30630/joiv.5.3.479

Harun, N. Z., Ariffin, N. A. H. M., & Abdullah, F. (2017). Changes and threats in the preservation of the traditional Malay landscape. *Planning Malaysia*, 15. https://doi.org/10.21837/pm.v15i4.318

Hassin, N., & Misni, A. (2019). Assessing the thermal performance of Negeri Sembilan traditional Malay house towards sustainable practice. *Environment-Behaviour Proceedings Journal*, 4(12), 289. https://doi.org/10.21834/e-bpj.v4i12.1914

Hassin, N., & Misni, A. (2021). Negeri Sembilan Malay house thermal performance evaluation towards sustainable practice. *Asian Journal of Environment-Behaviour Studies*, 6(19), 43–55. https://doi.org/10.21834/ajebs.v6i19.392

Hassin, N., & Misni, A. (2022). Developing methodology to assess the thermal comfort of traditional Malay house. *IOP Conference Series: Earth and Environmental Science*, 1067(1), 012023. https://doi.org/10.1088/1755-1315/1067/1/012023

Hatin, W., Nur-Shafawati, A., Etemad, A., Jin, W., Qin, P., Xu, S., ... & Zilfalil, B. (2014). A genome-wide pattern of population structure and admixture in Peninsular Malaysia Malays. *The HUGO Journal*, 8(1). https://doi.org/10.1186/s11568-014-0005-z

Hatin, W., Nur-Shafawati, A., Zahri, M., Xu, S., Li, J., Tan, S., ... & Zilfalil, B. (2011). Population genetic structure of Peninsular Malaysia Malay sub-ethnic groups. *PLOS ONE*, 6(4), e18312. https://doi.org/10.1371/journal.pone.0018312

Hidayat, W. (2011). Application of Malay traditional architecture elements as regional identity towards sustainable city. *Review of Urbanism and Architectural Studies*, 9(2), 1–27. https://doi.org/10.21776/ub.ruas.2011.009.02.4

Ismail, M., Bakar, A., Abas, N., Roosli, R., & Abdullah, S. (2015). Non-structural elements of the traditional Malay houses in the East Coast and Northern Peninsular Malaysia: Similarities and differences. *Applied Mechanics and Materials*, 747, 188–191. https://doi.org/10.4028/www.scientific.net/amm.747.188

Jaffar, S., & Kunapalan, H. (2021). Old Malay cities in Malay historiographical texts. *International Journal of Academic Research in Business and Social Sciences*, 11(7). https://doi.org/10.6007/ijarbss/v11-i7/10586

Jaffar, S., Sujud, A., & Muhammad, S. (2020). Vernacular architecture in old Malay building through Malay historiography. *International Journal of Academic Research in Business and Social Sciences*, 10(2). https://doi.org/10.6007/ijarbss/v10-i2/6927

Juhari, W., Tamrin, N., Daud, M., Isa, H., Nasir, N., Maran, S., ... & Zilfalil, B. (2014). A whole genome analysis of genetic variants in two Kelantan Malay individuals. *The HUGO Journal*, 8(1). https://doi.org/10.1186/s11568-014-0004-0

Karim, N. (2021). Exploring the roles of heritage museums in promoting intangible and tangible heritage in Kelantan. *Akademika*, 90, 181–193. https://doi.org/10.17576/akad-2020-9002-15

Khalit, N. (2023). Assessment of indoor thermal condition on traditional vernacular masjid: A case study on Masjid Kampung Laut, Malaysia. *Jurnal Kejuruteraan*, 35(3), 647–655. https://doi.org/10.17576/jkukm-2023-35(3)-12

Kinosyan, N., & Bashirova, E. (2021). The architecture of spectacular buildings in the city of Kazan in the context of national and regional traditions. *E3S Web of Conferences*, 274, 01016. https://doi.org/10.1051/e3sconf/202127401016

Nawayai, S. S. M., Denan, Z., & Abdul Majid, N. H. (2020). Readaptation of Malay vernacular architecture for indoor thermal comfort in modern masjids towards a sustainable design. *Planning Malaysia*, 18(12). https://doi.org/10.21837/pm.v18i12.751

Noor, N., & Nasir, M. (2019). The implementation of Malay traditional architectural elements in Mukim Sabak Mosque, Kota Bharu, Kelantan. *International Journal of Academic Research in Business and Social Sciences*, 9(9). https://doi.org/10.6007/ijarbss/v9-i9/6285

Othman, N., & Shuaib, A. (2013). Identiti senibina Melayu Islam dalam perancangan dan struktur ruang dalaman rumah tradisional Melayu Kelantan. *International Journal of Creative Future and Heritage (Teniat)*, 1(2), 35–48. https://doi.org/10.47252/teniat.v1i2.109

Sabil, A. (2020). Idea dan pendekatan seni bina Melayu moden dalam kalangan Arkitek Malaysia. *PhD Thesis, Universiti Putra Malaysia*.

Shuaib, A. A., & Olalere, F. E. (2013). Application of Kelantan traditional aesthetic values into the architecture of contemporary homes. *Arts and Design Studies*, 6, 15–25. https://doi.org/10.47252/teniat.v1i2.109

Sojak, S. D. M., & Utaberta, N. (2013). Typological study of traditional mosque ornamentation in Malaysia: Comparison between traditional and modern mosques. In *International Conference on Architecture and Shared Built Heritage Conference (ASBC 2013)*, Bali, Indonesia (pp. 101–118).

Toe, D., & Kubota, T. (2013). Field measurement on thermal comfort in traditional Malay houses. *AIJ Journal of Technology and Design*, 19(41), 219–224. https://doi.org/10.3130/aijt.19.219

Wahid, J., Abdullah, A., Saleh, B., & Awad, J. (2021). The wood carvings of two traditional timber mosques in Kelantan and Terengganu. *IOP Conference Series: Materials Science and Engineering*, 1101(1), 012026. https://doi.org/10.1088/1757-899X/1101/1/012026

Yusof, A., Rahman, K., Sabil, A., Utaberta, N., & Yusuf, N. (2021). The adaptation of Islamic principles in Sarawak traditional Malay house. *Journal of Islamic Architecture

JOURNAL OF ARCHITECTURE, PLANNING & CONSTRUCTION MANAGEMENT
Volume 14 Issue 2, 2024 E-ISSN: 2462-2222 ISSN: 2231-9514

EMERGING TECHNOLOGIES FOR MAINTENANCE MANAGEMENT OF RESIDENTIAL AND COMMERCIAL HIGH-RISE BUILDINGS: BARRIERS AND STRATEGIES FOR IMPROVEMENT

Received: 13 September 2024 | Accepted: 07 December 2024 | Available Online: 07 December 2024
DOI: 10.31436/japcm.v14i2.933

Muhammad Wafiq Mohd Sakhaf[1], Mohd Fairullazi Ayob[1*]

[1] Department of Quantity Surveying, Kuliyyah of Architecture and Environmental Design, International Islamic University Malaysia, jalan Gombak, 53100 Kuala Lumpur, Malaysia.*

Corresponding author: **Mohd Fairullazi Ayob*
Corresponding author's email: fairullazi@live.iium.edu.my

ABSTRACT

The rapid development in the innovation of technologies facilitates the facilities management (FM) industry in terms of efficiency and sustainability. In recent years, the adoption of emerging technologies has been attracting a lot of interest among stakeholders. This is because Malaysia is in the process of transforming towards smart facilities management (Smart FM) from traditional facilities management (TFM). Therefore, this paper prepared to present the outcome of the study on the types of emerging technologies used, drivers, barriers and strategies towards the adoption of smart FM of residential and commercial high-rise buildings in Klang Valley. A semi-structured interview with facilities management (FM) professionals was conducted to identify the types of emerging technologies used in the Malaysian FM industry, drivers, barriers as well as strategies for adopting the advanced technologies for maintenance management of high-rise buildings. From the study, the FM professionals validated that Building Information Modelling (BIM) is the most effective and efficient technology to be used in the maintenance management of residential and commercial high-rise buildings. The emerging technologies help to increase building efficiency and are suitable for long-term investment planning. However, high adoption costs and the limited number of experts on the technologies in Malaysia are the major barriers. Despite the barrier, the significant strategy was found to be effective in improving the adoption through training and workshops. Thus, this paper provides a comprehensive understanding of emerging technologies and marks a turning point for an organisation to consider adoption.

Keywords: Emerging technologies, Maintenance management, High-rise buildings, Strategies

1.0 INTRODUCTION

In the new global economy, the National Construction Policy (NCP) 2030 stresses the transformation of the whole construction sector towards the digitalization era and achieving inclusive and sustainable national development by 2030. Hence, exposure to the adoption of emerging technologies has been shown to be related to endorsing the Construction Industry Development Board (CIDB) Strategic Plan. According to the CIDB Malaysia (2020), Building Information Modelling (BIM), Autonomous Construction, Augmented Reality (AR) and Virtualisation, Cloud and real-time collaboration, Big Data (BD) and Predictive Analysis, Internet of Things (IoT), Blockchain and Artificial Intelligence (AI) are the emerging

technologies defining Malaysia's construction 4.0 that closely related towards optimizing maintenance management of high-rise buildings in Klang Valley. Besides that, another significant aspect of the adoption of emerging technologies in the FM industry is to fulfil the Environmental, Social, and Governance (ESG), achieve the Sustainable Development Goals (SDGs) 6,7,9 and 11 as well as establish the Sustainable Facilities Management (SFM).

There is a growing body of literature that recognises some facilities management (FM) companies and contractors in Malaysia are still practising traditional facilities management (TFM) systems that involve reactive maintenance, manual process of maintenance management, space management, and record-keeping (Myeda & Pitt, 2014). A study by Hou et al. (2024) proved that TFM leads to serious problems because it is time-consuming, high cost, lacks real-time data, requires more manpower, and increases downtime. The adoption of emerging technologies in facilities management of high-rise buildings would likely overcome the problem because it provides real-time data, automated workflow, predictive analysis, and faster decision-making. The paper is prepared to present the outcome of the study on the development of emerging technologies and their significant drivers, barriers, as well as strategies to adopt smart FM in Malaysia. The objectives of this paper are as follows:

1. To identify the types of emerging technology used for optimizing maintenance management of residential and commercial high-rise buildings in Klang Valley.
2. To determine the drivers and barriers in utilizing emerging technologies for maintenance management of residential and commercial high-rise buildings in Klang Valley.
3. To identify strategies for improving the utilization of emerging technologies for maintenance management of residential and commercial high-rise buildings in Klang Valley.

2.0 LITERATURE REVIEW

2.1 Facilities Management in Malaysia

In the new global economy, Construction Strategic Plan 4.0 (2021-2025) stresses the process of implementing modern technology to encourage the digitalization of the facilities management industry. FM in Malaysia has fallen behind the technological curve due to a lack of technological advancement compared to other developed countries (Bakar & Kamaruzzaman, 2022). The development of smart FM will be a remarkable approach as it works concurrently with the goals of future facility management (Foo, 2024). Thus, there is a strong possibility that emerging technologies will help Malaysia achieve sustainable facilities management (SFM) by 2030, as mentioned in the National Construction Policy (NCP) 2030.

2.1.1 Traditional Facilities Management (TFM)

Traditional FM (TFM) involves the management of a facility by using manual processes such as paper-based systems, spreadsheets, and phone calls (KJ Technical Services Sdn. Bhd, 2023). Nowadays, TFM is found to be an inefficient way of managing high-rise buildings as it is time-consuming, space-consuming, and costly (Alam, 2021). A previous study of TFM conducted by Zhan et al. (2023) reveals that TFM is still using the reactive maintenance approach to sustain

building performance which most of the information systems are Computer-Aided Facility Management (CAFM). The Nest Integrated Facilities Management (Nest IFM) (2023) further explains that TFM lacks technology integration, which leads to slower response times, manual tracking, and a lack of real-time insight. In Malaysia's context, TFM is still widely used in the FM industry among the key players.

2.1.2 Smart Facilities Management (Smart FM)

Hou (2023) defines Smart FM as the integration of systems, processes, technologies, and personnel to enhance building facilities. Al-Kasasbeh et al. (2021) mention that traditional FM offers inefficient remote work and slow information updates. The implementation of smart FM influences the improvement of traditional FM and achieving sustainability in the built environment by enhancing workplace productivity and occupant well-being, as well as saving cost and time. Recently, the Malaysian government has taken into account the system to enhance the assets and facilities management to develop and transform the traditional FM into smart FM (Awang et al., 2017).

2.1.3 Sustainable Facilities Management (SFM)

Sustainable Facilities Management (SFM) is closely related to Smart FM, as both contribute towards building efficiency and eco-friendly buildings. Opoku and Lee (2022) are more concerned that SFM will help minimise energy, water, and waste in the maintenance and operation of buildings, create net zero energy buildings, and integrate data-driven technologies. Zakaria et al. (2018) created a SFM model consisting of social, environmental, and economic aspects that are designed to fulfil the aim of Smart FM and maintenance management. SFM and Smart FM shared the same target, which is to save costs, help in the decision-making process, access data using technology, and maximise efficiency and sustainability in energy management (Okoro, 2023). Thus, Malaysia aims to achieve SFM by adopting emerging technologies, as it shares the same purpose of increasing building performance and efficiency.

2.2 Maintenance Management of high-rise buildings

Abbood et al. (2021) pointed out that most residential and commercial high-rise buildings can be determined by their overall height exceeding 36 meters or the number of floors that exceed 12 floors. On top of that, high-rise buildings require maintenance management which refers to a systematic process of planning, organising, operating, and handling the maintenance activities of assets, including the management of resources (Ogunbayo et al., 2022). Maintenance management is significant towards high-rise buildings in terms of safety assurance, regulation compliance, energy efficiency, cost-effectiveness, user satisfaction, and property value. Au-Yong et al. (2019) identify the routine maintenance for residential and commercial high-rise buildings are water supply system, lift system, power supply system, security system, cleaning services, firefighting system, and air conditioning system. CIDB Malaysia (2020) listed out the issues and challenges of implementing maintenance management for high-rise buildings in Malaysia are unavailability of building maintenance policy, high maintenance cost, inefficient maintenance management, and unsatisfied end-users. However, these issues can be overcome by establishing proper planning, adopting emerging technologies, conducting proper routine maintenance, and enforcing building

maintenance policies. The following sub-sections will discuss the type of maintenance management that has been practised in the facilities management industry.

2.2.1 Reactive maintenance

Sari (2018) noted that reactive maintenance is a maintenance process that is performed once the breakdown occurs. In Malaysia, most facility management organisations still apply reactive maintenance strategies as they offer lower upfront costs and less manpower. Au-Yong et al. (2019) pointed out that the majority of condominiums conducted the maintenance works on a reactive basis because it offers lower upfront costs and less manpower to save costs for short-run planning. However, the cost of reactive maintenance can be absolutely higher when the breakdowns, defects, and repairs become more frequent in the building.

2.2.2 Preventive maintenance

Preventive maintenance is maintenance carried out at a predetermined time or to other prescribed criteria with the intention of reducing the likelihood of an item not meeting an acceptable condition (Yahya & Ibrahim, 2011). Chua et al. (2018) claimed preventive maintenance as an efficient maintenance strategy in order to guarantee the constant and effective usage of building systems and their components. It is believed preventive maintenance is one of the best maintenance management strategies because it reduces the maintenance cost for major damage, improves asset safety, and minimises downtime. For instance, Brazil utilises BIM during preventive maintenance to identify potential issues, damages, errors, and defects in high-rise buildings.

2.2.3 Predictive maintenance

Predictive maintenance is the process of analysing data in order to predict potential building failures through monitoring and processing, diagnosis and prognosis, and maintenance decision-making (Zonta et al., 2020). Furthermore, predictive maintenance involves data collection and analysis from sensors, historical maintenance records, and machine performance data and benefits maintenance management in terms of reducing equipment downtime, improving equipment reliability, lowering maintenance costs, and reducing the risk of damages (Gispert et al., 2023). By drawing the concept of predictive maintenance, Zonta et al. (2020) mention in their findings that predictive maintenance allows them to predict trends, behaviour patterns, and correlations in order to enhance the decision-making process for the maintenance task, namely preventing downtime, by foreseeing possible failures in advance.

2.3 Emerging Technologies

There are several types of emerging technologies that have been adopted by the facilities management (FM) practitioners for improving their maintenance management practices (Matarneh et al., 2019; Olimat et al., 2023). Table 1 presents in summary the outcome of review of the emerging technologies and their functions, which have been applied to improve the facilities management practice.

Table 1: Types of emerging technologies used in facilities management

Types	Function
Building Information Modelling (BIM)	Improve space management, streamline maintenance works, ensure efficient use of energy, undertake economical retrofits and renovations, and enhance lifecycle management (Matarneh et al., 2019).
Wireless Sensor Network (WSN)	Monitor and control the building's functions, such as HVAC, security, and lighting systems, from its environment by accessing the real-time data collection process (Bal, 2012).
Internet of Things (IoT)	Collect real-time information on the condition of facilities remotely, forecast the risk status of facilities, and recommend a critical decision-making solution (Sidek et al., 2022).
Information Communication Technology (ICT)	Improve information management, supply chain activities, and communication in FM by using email, maintenance management software, computer-aided facilities management (CAFM), building energy management (BEM), and agile software (Aziz et al., 2016).
Digital Twin (DT)	Optimise building lifecycle management by estimating and analysing dynamic changes. It integrates virtual information models with real-time data, enhancing decision-making from project initiation to demolition (Ozturk, 2021).
Geographic Information System (GIS)	Provides real-time map-based data to the facilities management teams in order for them to find asset information, report critical issues, make data-driven decisions, and monitor facility operations (Young, 2023).
Augmented Reality (AR)	Identify parts involved in the maintenance activity, measure conductor current and component temperatures, display technical paperwork, and display unforeseen components behind the walls, furniture, ceiling, and floor (Sadeghie, 2024).
Unmanned Aerial Vehicles (UAV)	Access real-time data on the inaccessible parts of high-rise buildings in a lower-cost and lower-risk approach, as well as help to perform maintenance and security activities by capturing images and video (Wood, 2020).
Artificial Intelligence (AI)	Forecast maintenance needs, enhance the security of buildings with AI-powered surveillance systems, analyse space utilization and optimization, and reduce carbon footprints by monitoring building sustainability in terms of carbon emissions, energy usage, water usage, and waste management (Datta, 2023).
Big Data (BD)	Streamline labour-intensive maintenance functions and expand sector operations into higher value-added activities. BD is automating maintenance activities, work orders, and energy management in order to reduce costs (Konanahalli et al., 2018).

2.4 Drivers of Utilizing Emerging Technologies for Optimizing Maintenance Management of High-Rise Buildings in Klang Valley

Smart FM, incorporating emerging technologies and innovative business practices is expected to significantly improve the future facilities management industry especially for high-rise

buildings. It enhances cost-effectiveness, energy efficiency, and safety for building users, while also contributing to sustainable built environments (Zhan et al., 2023). Moreover, it improves asset performance, allows for rapid response time, and meet government standards (Alam, 2021; Okoro, 2023). Ambient technology, such as AR, can enhance space utilization, workplace experience, and occupant comfort (Fairchild, 2019).

2.5 Barriers of Utilizing Emerging Technologies for Optimizing Maintenance Management of High-Rise Buildings in Klang Valley

Researchers have identified barriers to the adoption of smart FM, including high costs, lack of skills, poor data management, financial capability, and time (Hamid et al., 2021; Durdyev et al., 2021; Sulaiman et al., 2021). New barriers include lack of standards, guidelines, government support, cybersecurity risks and technological changes (Sari, 2018). The Nigerian FM industry faces insufficient awareness of BIM integration, lack of legal frameworks, limited knowledge, poor acceptance, and resistance to change (Okwe et al., 2022).

2.6 Strategies to Improve the Utilization of Emerging Technologies for Maintenance Management of High-Rise Buildings in Klang Valley.

The Malaysian FM market is experiencing a 5.54% compound annual growth rate (CAGR), necessitating a maintenance strategy to increase by 2028 as reported by Mordor Intelligence (2023). To achieve this, Malaysia is focusing on creating a 5G ecosystem for buildings, satellites, networking, and smart automation. According to Yahya and Ibrahim (2012), the Maintenance Achievement Index (MAI) can be developed to benchmark high-rise building maintenance performance. Next, the most effective strategies for the adoption of smart technologies in the construction industry are the training of a skilled construction workforce, the provision of government incentives, and communication management (Hwang et al., 2022). The government is also implementing policies to support Construction Revolution 4.0 in the FM industry, enhancing the life cycle of buildings (Hamid et al., 2021).

3.0 METHODOLOGY

Yahya and Ibrahim (2012), Awang et al. (2017), and Hamid et. al (2021) show that the adoption of emerging technologies for maintenance management of residential and commercial high-rise buildings is very rare and rudimentary in Malaysia. Hence, a qualitative research strategy is adopted in this study to confirm this statement. Also, a semi-structured interview was conducted to gather information and opinions from the FM professionals based on a set of criteria. This approach helps to obtain further in-depth information on the usage of emerging technologies for the maintenance management of high-rise buildings. The criteria of the respondents' selection are i) must have a few years' experience in the construction industry, ii) more than one (1) year of experience in the FM industry, and iii) possess knowledge or skills of using emerging technologies. An open-ended question was used to allow respondents to elaborate on their opinions and provide recommendations on the research topics. Meanwhile, the close-ended questions using the Likert scale act as a rating tool to measure the respondent's level of agreement in a convenient and faster way. However, in determining the types of emerging technologies used in the maintenance management of high-rise buildings, frequency distribution was used to identify the ranking of emerging technologies used in the Malaysian FM industry based on the multiple-choice

questions. Hence, this combination assists the researcher in analysing the data collected and presented in a structured manner. Then, the rank of the drivers, barriers and strategies have been analysed using descriptive analysis based on the mean score and standard deviation. The highest mean score represents the higher rate of agreement towards the statement. Meanwhile, the lower standard deviation indicates the higher accuracy of data to the mean.

4.0 RESULTS

4.1 Interviewees' Background

Table 2 summarises the interviewees' background consists of FM professionals that come from different organisations. All interviewees have involved with the maintenance management of residential and commercial high-rise buildings in Klang Valley area. Thus, this led to the conclusion that the interviewees engaged in the study met the specified criteria of respondents' selection.

Table 2: Interviewees Background

Interviewee	Company	Position	Years of experience	Type of high-rise
A	Sunway Property and Facilities Management	Property Executive	12	Residential & Commercial
B	Sunway Property and Facilities Management	Manager	2	Residential
C	APM Property Management Asia	Senior Building Engineer	7	Residential & Commercial
D	Sunway Property	Senior Engineer	17	Commercial
E	Fathaos Enterprise	Director	25	Residential & Institutional
F	Besteel Engtech	Quantity Surveyor	5	Residential
G	Satar Empire	Quantity Surveyor	1	Residential

4.2 Types of emerging technologies

Table 3: Emerging Technologies used in Malaysian FM industry.

Types	Frequency	Percentage (%)	Rank
Building Information Modelling (BIM)	7	36.8	1
Big Data (BD)	3	15.8	2
Artificial Intelligence (AI)	2	10.5	3
Internet of Things (IoT)	2	10.5	4
Geographic Information System (GIS)	2	10.5	5

The high demand for the types of advanced technology used in an organisation for the purpose of maintenance management of high-rise buildings in Klang Valley is BIM at 36.8% followed by BD system at 15.8%. The interviewees added that some organisation practicing BIM such as Building Science Technology (BST), Building Management System (BMS) as well

as Computerised Maintenance Management System (CMMS). Moreover, AI, IoT as well as GIS have a similar percentage, which is 10.5%, are rarely used for maintenance management work on high-rise buildings. Next, the ICT, AR, and UAV, WSN and DT have not yet been broadly applied in Malaysia FM industry as some facilities management companies have no interest in the adoption of these technologies. Furthermore, the cost associated per month with adopting advanced technology in their organization for the purpose of maintenance management of high-rise buildings is less than RM10,000.00 and RM30,000.00 to RM40,000.00 depending on the type of technology adopted.

4.3 Driver and barriers in adopting emerging technologies

Table 4: Drivers in adopting emerging technologies

Drivers	Mean	Standard Deviation	Rank
Increase building efficiency	4.57	0.53	1
Long term investment planning	4.57	0.79	2
Improve asset performance	4.43	0.53	3
Improve sustainability and ESG	4.43	0.53	4
Faster decision making and problem solving	4.43	0.79	5

Table 4 shown that most of the interviewees strongly agreed that the emerging technologies enable to increase building efficiency and good for long term investment planning. Moreover, the adoption of the emerging technologies also helps to improve the assets performance, sustainability and ESG in the built environment. Moreover, the results above shown that emerging technologies provide faster decision making and problem solving for maintenance works of high-rise buildings. In addition, cost effectiveness and optimise space utilisation were found to be the minor drivers in adopting the emerging technologies in Malaysian FM industry.

Table 5: Barriers in adopting emerging technologies

Barriers	Mean	Standard Deviation	Rank
High adoption cost	4.57	0.53	1
Lack of expertise	4.14	1.07	2
High cybersecurity risk	3.86	0.69	3
Lack of government supports	3.71	0.95	4
Poor data management	3.29	1.11	5

Table 5 presented the barriers in adopting emerging technologies for maintenance management of high-rise buildings in Klang Valley through mean score and standard deviation retrieved from the interview session. The adoption cost of emerging technologies is very high for an organisation that facing financial constraints. Moreover, lack of expertise on the emerging technologies found to be a major barrier in Malaysian FM industry. Besides, the barrier towards the adoption also includes high cybersecurity risk, lack of government supports and poor data management. One of the interviewees added a barrier that their organisation faces are difficulty to find the right person to manage the technology and evolving of new technologies in the future.

4.4 Strategies to improve the adoption of emerging technologies

Table 6: Strategies to improve the adoption of emerging technologies

Strategies	Mean	Standard Deviation	Rank
Provide training and workshop	4.43	0.53	1
Spread awareness	4.43	0.53	2
Implement predictive modelling system	4.29	0.49	3
Collaboration among facilities manager	4.29	0.49	4
Government develops a policy	4.14	0.38	5

Based on Table 6, the potential strategies found to be effective to adopt emerging technologies is by providing a training and workshop to the facilities management practitioners. Next, the FM organisation or authority need to spread the awareness on the application of emerging technologies to facilitates the maintenance of high-rise buildings. The other strategies to improve the adoption of emerging technologies are through implementation of predictive modelling system, collaboration among facilities manager, development of policy by government and focus on long-run business plan. Few interviewees shared their organisation strategies that may be helpful in the industry such as outsourcing company that have expertise or provide services of the emerging technology and enhance the adoption by following international standards.

5.0 DISCUSSIONS

5.1 Emerging Technologies towards FM

Bakar and Kamaruzzaman (2023) stated that the FM industry in Malaysia still lacked technological innovation and has been long criticised due to insufficient studies that indicate the actual adoption of FM technology. However, the findings explained that emerging technologies started to be used widely in Malaysia as they influence the efficiency of maintenance management in residential and commercial high-rise buildings in Klang Valley. The first research objective has been proved because it revealed the types of emerging technology used frequently in the maintenance management of high-rise buildings in Klang Valley which is BIM followed by BD at 36.8% and 15.8%, respectively. This result is consistent with findings by Ariffin et al. (2023), who found that 20% of FM organisations in Malaysia have been implementing BIM in their practices, such as Building Management System (BMS) and Computerised Maintenance Management System (CMMS). BIM for the maintenance of fire alarm systems, lifts, and pumps in high-rise buildings. This finding is in line with a previous study by Safayet et al. (2021) that emphasized the development of BIM for fire alarm systems in order to reduce the fire impact on high-rise buildings, complexes, and enclosed spaces.

Besides that, the other emerging technologies that have been used in the maintenance management of high-rise buildings in Klang Valley are AI, IoT, and GIS at 10.5% while ICT, AR and UAV at 5.3%. On the other hand, the majority of the interviewees (28.6%) agreed that the cost associated per month is less than RM10,000.00 and RM30,000.00 to RM40,000.00. In accordance with the present results, a previous study by ProV International Inc. (2022) described that the

factors that affect the adoption cost are the specification of the technology, the size of the buildings, the geographic location of the facility, and the frequency of operation.

5.2 Key drivers and significant barriers

The key driver of emerging technologies' adoption is to increase building efficiency in terms of maintenance and data management. This result is consistent with findings by another researcher who found that the maintenance work efficiency in a building, such as inspection work, is higher using an AR compared to the traditional paper-based approach (Chung et al., 2021). Besides, this finding may help us to understand the following key drivers towards the adoption of emerging technology long-term investment planning as it offers higher profitability (Peacock Engineering, 2021). Next, improvement of asset performance, sustainability, and ESG, are the important drivers. Previous research proves that emerging technologies will enhance sustainability and influence energy efficiency (Zhan et al., 2023). Perhaps, the least influential drivers of the adoption of smart FM for maintenance management of high-rise buildings are faster decision-making, problem-solving, cost-effectiveness and optimization of space utilisation.

Subsequently, the major barrier to adopting smart FM for maintenance management of high-rise buildings is high adoption costs. This finding is in accordance with recent studies indicating that this factor was the most significant barrier in their research on the barriers to the implementation of BIM for FM other than lack of expertise and unfamiliarity with the technology (Durdyev et al., 2022). Apart from the high adoption cost, another significant finding is the adoption of emerging technologies in FM is obstructed due to a lack of expertise among the FM team. This is aligned with the research conducted by Singh and Kumar (2024) on analysing the barriers to blockchain-enabled BIM adoption in FM. In this current study, poor data management by the FM organization was found to be a minor barrier because the FM practitioners have neutral perspectives on this barrier. However, this finding is contradicted by other research in the United Kingdom FM sector that considers data management issues to be one of the significant barriers (Konanahalli et al., 2020). Additionally, Zhan et al. (2023) findings in their research on the barriers to the adoption of smart FM in Singapore agreed with one of the interviewee's opinions towards the development of new technology in the future would affect the current technology.

5.3 Potential strategies

The findings from this study show a remarkable strategy for improving the adoption of smart FM for maintenance management of high-rise buildings is to provide training and workshops to learn the skills of using the technology. CIDB Malaysia has started to provide a training programme to develop skills and knowledge on BIM in FM for FM professionals (Hamid et al., 2021). From the study reported by Hamid et al., (2021), spreading awareness about the function of the technology may attract stakeholders to implement smart FM in their organisation. Next, the findings of this study show that the implementation of predictive modelling would help to improve the adoption of smart FM, followed by excellent collaboration among facility managers and the development of a policy framework. However, the strategy that focuses on the long-run business plan considering the ESG were believed as the least potential strategy in this study. Interviewee B added a strategy that was helpful towards their organisation which is outsourcing companies that can provide services using emerging technology to help make maintenance management more efficient and cost-effective. Macro (2024) supports interviewee B because they have a similar idea, which is to

outsource the maintenance work to the facilities management expert in terms of skills and technology.

6.0 CONCLUSION

This research provides a better understanding of the types of emerging technology used for the maintenance management of high-rise buildings as well as their associated costs per month. Building Information Modelling (BIM) was found to be the emerging technology used the most in the Malaysian FM industry with the cost associated per month being less than RM10,000.00. Moreover, the key drivers are increasing building efficiency, long-term investment planning, improving asset performance, improved sustainability and ESG and faster decision-making. In contrast, the significant barriers towards the adoption are high adoption cost, lack of expertise, high cybersecurity risk, lack of government support and poor data management. Also, this research confirms previous findings and contributes additional evidence on the strategies for improving the application of emerging technologies in FM. The potential strategies are providing training and workshops, spreading awareness, implementing a predictive modelling system, collaborating among facility managers and developing a policy. In addition, further research is recommended to estimate and compare the whole life cost and life cycle cost (LCC) of the emerging technology used in facility management practices due to limited resources. This would be a fruitful area for further research, as it would be beneficial for the players in facility management, including stakeholders and facility managers.

ACKNOWLEDGMENTS

This study builds upon prior research conducted by the first author presented in the following unpublished dissertation: *The Adoption of Smart Facilities Management (Smart FM) for Maintenance Management of High-rise Buildings in Klang Valley* (2024). This dissertation was undertaken over approximately nine months under the supervision of the second author at the International Islamic University Malaysia.

REFERENCES

Abbood, I., Jasim, M., & Weli, S. (2021). View of high-rise buildings: Design, analysis, and safety, *International Journal of Architectural Engineering Technology*, 8, 1–13.

Alam, R. N. (2021, January 19). Benefits of integrated facilities management compared to traditional practices. https://www.linkedin.com/pulse/benefitsintegrated-facilities-management-compared-traditional-alam/

Al-Kasasbeh, M., Abudayyeh, O., & Liu, H. (2021). An integrated decision support system for building asset management based on BIM and Work Breakdown Structure. *Journal of Building Engineering*, 34, 101959.https://doi.org/10.1016/j.jobe.2020.101959

Ariffin, E. Y., Mustafa, N. E., & Sapri, M. (2023). Perspective towards the Perceived Benefits and Challenges on Building Information Modelling - Facility Management (BIM-FM) Integration at an Early Stage of BIM Projects. *108 Malaysian Journal of Real Estate/International Journal of Real Estate Studies*, 17(1), 70–82. https://doi.org/10.11113/intrest.v17n1.198

Au-Yong, C. P., Ali, A. S., & Chua, S. J. L. (2019). A literature review of routine maintenance in high-rise residential buildings. *Journal of Facilities Management*, 17(1), 2–17. https://doi.org/10.1108/jfm-10-2017-0051

Awang, M., Mohammed, A. H., Salleh, M. N. M., Johari, N. H., & Khair, N. (2017). Facilities Management-Future Prospect in Malaysia. *Sains Humanika*, *9*(1–5). https://doi.org/10.11113/sh.v9n1-5.1170

Aziz, N. D., Nawawi, A. H., & Ariff, N. R. M. (2016). ICT evolution in Facilities Management (FM): Building Information Modelling (BIM) as the latest technology. Procedia - *Social and Behavioral Sciences*, 234,

363–371. https://doi.org/10.1016/j.sbspro.2016.10.253
Bakar, Z. A., & Kamaruzzaman, S. N. (2023). Assessing key technology for facilities management in Malaysia. *Journal of Surveying, Construction & Property*, 14(1), 40–54. https://doi.org/10.22452/jscp.vol14no1.4
Bal, M. (2012, January). Collaborative wireless sensor networks for facilities management. *Research Gate*. https://www.researchgate.net/publication/292852910_Collaborative_Wireless_Sensor_Networks_for_facilities_management
Chua, S. J. L., Zubbir, N. B., Ali, A. S., & Au-Yong, C. P. (2018). Maintenance of high-rise residential buildings. *International Journal of Building Pathology and Adaptation*, 36(2), 137–151. https://doi.org/10.1108/ijbpa-09-2017-0038
Chung, S., Cho, C., Song, J., Lee, K., Lee, S., & Kwon, S. (2021). Smart facility management system based on open BIM and augmented reality technology. *Applied Sciences*, 11(21), 10283. https://doi.org/10.3390/app112110283
CIDB Malaysia. (2020). *Construction 4.0 Strategic Plan (2021-2025)*. https://www.cidb.gov.my/wp-content/uploads/2022/12/CR4_web_compressed.pdf
Datta, A. (2023, September 21). 5 Benefits of AI in facility management. Facility Technology. https://factech.co.in/blog/5-benefits-of-ai-in-facility-management/
Durdyev, S., Ashour, M., Connelly, S., & Mahdiyar, A. (2022). Barriers to the implementation of Building Information Modelling (BIM) for facility management. *Journal of Building Engineering*, 46, 103736. https://doi.org/10.1016/j.jobe.2021.103736
Fairchild, A. M. (2019). Twenty-First-Century smart facilities management: Ambient networking in intelligent office buildings. In Computer communications and networks (pp. 271–289). https://doi.org/10.1007/978-3-030-04173-1_12
Foo, I. (2024). Unpacking the sustainability benefits of Smart FM. *APREA Knowledge Brief*. https://knowledgebrief.aprea.asia/articles/unpacking-thesustainability-benefits-of-smart-fm/
Gispert, D. E., Yitmen, İ., Sadri, H., & Taheri, A. (2023). Development of an ontology-based asset information model for predictive maintenance in 112 building facilities. *Smart and Sustainable Built Environment*. https://doi.org/10.1108/sasbe-07-2023-0170
Hamid, Z., Kamaruzzaman, S., Ghani, M., & Ibrahim, I. (2021). Facilities management initiative and empowerment for construction industry in Malaysia. Construction Industry Development Board Malaysia (CIDB). https://www.cidb.gov.my/wp-content/uploads/2022/07/215-Facilities-Management-Intiatives-Empowerment-fo-Construction-Industry-in-Malaysia-min.pdf
Hou, C. (2023). Factors influencing smart facilities management – Stakeholder perspectives and the implication. *Journal of Building Engineering*, 75, 106959. https://doi.org/10.1016/j.jobe.2023.106959
Hou, H., Lai, J. H., Wu, H., & Wilkinson, S. J. (2024). Guest editorial: Facilities management – a future proof management approach towards sustainability. *Facilities*, 42(3/4), 181–184. https://doi.org/10.1108/f-03-2024-165
Hwang, B., Ngo, J., & Teo, J. Z. K. (2022). Challenges and strategies for the adoption of smart technologies in the construction industry: The case of Singapore. *Journal of Management in Engineering*, 38(1). https://doi.org/10.1061/(asce)me.1943-5479.0000986
KJ Technical Services Sdn. Bhd. (2023, March 20). Mobile facilities management vs. Traditional facilities management: What's the difference? https://www.linkedin.com/pulse/mobile-facilities-management-vs-traditional/
Konanahalli, A., Marinelli, M., & Oyedele, L. O. (2020). Drivers and Challenges Associated with the implementation of big data within U.K. Facilities Management Sector: An Exploratory Factor Analysis approach.
Konanahalli, A., Oyedele, L., Marinelli, M., & Selim, G. (2018). Big Data: a new revolution in the UK facilities management sector. RICS Research Trust. https://www.rics.org/news-insights/research-and-insights/big-data--a-new-revolution-in-the-uk-facilities-management-sect
Macro. (2024, February 26). Facility management outsourcing: pros, cons, and best practices. *LinkedIn*. https://www.linkedin.com/pulse/facility-management-outsourcing-pros-cons-best-practices-mryte/
Matarneh, S. T., Danso-Amoako, M., Al-Bizri, S., Gaterell, M., & Matarneh, R. (2019). BIM for FM. *Facilities*, 38(5/6), 378–394. https://doi.org/10.1108/f-07-2018-0084
Mordor Intelligence. (2023). Malaysia facility management market insights. https://www.mordorintelligence.com/industry-reports/malaysia-facility-management-market
Myeda, N. E., & Pitt, M. (2014). Facilities management in Malaysia. *Facilities*, 32(9/10), 490–508. https://doi.org/10.1108/f-02-2012-0012
Nest Integrated Facilities Management. (2023, November 2). Understanding facilities management services:

A comprehensive look at IFM vs. traditional FM. NEST | Integrated Facilities Management. https://www.enternest.com/blog/ifm-vs.-traditional-fm

Ogunbayo, B. F., Aigbavboa, C. O., Thwala, W., Akinradewo, O., Ikuabe, M., & Adekunle, S. A. (2022). Review of culture in maintenance management of public buildings in developing countries. *Buildings*, *12*(5), 677. https://doi.org/10.3390/buildings12050677

Okoro, C. (2023). Sustainable facilities management in the built environment: A Mixed-Method review. *Sustainability*, 15(4), 3174. https://doi.org/10.3390/su15043174

Okwe, E. I., Olanrewaju, O. I., Heckman, M., & Chileshe, N. (2022). Barriers to building information modelling and facility management practices integration in Nigeria. *Journal of Facilities Management*, 21(5), 845–865. https://doi.org/10.1108/jfm-12-2021-0153

Olimat, H., Liu, H., & Abudayyeh, O. (2023). Enabling technologies and recent advancements of smart facility management. *Buildings*, *13*(6), 1488. https://doi.org/10.3390/buildings13061488

Opoku, A.; Lee, J.Y. (2022). The Future of Facilities Management: Managing Facilities for Sustainable Development. Sustainability 2022, 14, 1705. https://doi.org/10.3390/ su14031705

Ozturk, G. B. (2021). Digital twin research in the AECO-FM industry. *Journal of Building Engineering*, *40*, 102730. https://doi.org/10.1016/j.jobe.2021.102730

Peacock Engineering. (2021, February 17). Why FM is investing in technology to deliver efficiencies - Peacock Engineering. https://peacockengineering.com/why-fm-is-investing-in-technology-to-deliver-efficiencies/

ProV International Inc. (2022, September 27). How much does facilities management software cost? https://www.provintl.com/blog/how-much-does-facilities-management-software-cost

Sadeghie, S. (2024, January 13). AR for Facility Management - Neuroject. Neuroject. https://neuroject.com/ar-for-facility-management/

Safayet, Md. A., Rahman, M., & Anam, S. M. A. (2021). Development of Building Information Modeling (BIM)-based real-time fire alert system to reduce fire impact in Bangladesh. *Jordan Journal of Civil Engineering*,15(3), 421–434. https://jjce.just.edu.jo/Home/ShowPaper.aspx?data=YHh7E8zpPUliTxQ3W%2bcHnbOOvEQYQ7X5hyyrLglMk0k%3d

Sari, A. A. (2018). Understanding facilities management practices to improve building performance: The opportunity and challenge of the facilities management industry over the world. MATEC Web of Conferences, 204, 01018. https://doi.org/10.1051/matecconf/201820401018

Sidek, N., Ali, N., & Alkawsi, G. (2022). An integrated success model of Internet of things (IoT)-Based services in facilities management for public sector. Sensors, 22(9), 3207. https://doi.org/10.3390/s22093207

Singh, A. K., & Kumar, V. P. (2024). Analyzing the barriers for blockchain-enabled BIM adoption in facility management using best-worst method approach. *Built Environment Project and Asset Management*, 14(2), 164–183. https://doi.org/10.1108/bepam-04-2023-0080

Sulaiman, M., Sulaiman, M., Liu, H., Binalhaj, M., Al-Kasasbeh, M., & Abudayyeh, O. (2021). ICT-based integrated framework for smart facility management: an industry perspective. *Journal of Facilities Management*, 19(5), 652–680. https://doi.org/10.1108/jfm-11-2020-0084

Wood, J. (2020, March 31). Benefits of drones in FM. Commercial Design. https://www.commercialdesignindia.com/products/5956-benefits-of-drones-in-fm

Yahya, M. R., & Ibrahim, M. N. (2011, November). Building Maintenance Policy Issues in High Rise Commercial Buildings [Paper presentation]. The 2nd International Conference on Public Policy & Social Sciences (ICoPS) 2011: "Socio-economic Transformation: Issues and Challenges in the 21st Century, Kuching, Sarawak, Malaysia.

Yahya, M.R., & Ibrahim, N. (2012). Building Maintenance Achievement in High Rise Commercial Building: A Study in Klang Valley, Malaysia.

Young, M. (2023, May 4). Geographic Information Systems (GIS) in Facility Management - May 2023 - Haag Global. Haag Global.

Zakaria, I. B., Hashim, S. Z., & Ahzahar, N. (2018). Critical Success Factor for Sustainable Facilities Management: A Review of Literature. *International 126 Journal of Academic Research in Business and Social Sciences*, 8(7), 469– 480.

Zhan, H., Hwang, B., Zhu, H., & Ang, S. H. (2023). Towards a sustainable built environment industry in Singapore: Drivers, barriers, and strategies in the adoption of smart facilities management. *Journal of Cleaner Production*, 425, 138726. https://doi.org/10.1016/j.jclepro.2023.138726

Zonta, T., Da Costa, C. A., Da Rosa Righi, R., De Lima, M. J., Da Trindade, E. S., & Li, G. (2020). Predictive maintenance in the industry 4.0: A systematic literature review. *Computers & Industrial Engineerin*g, 150, 106889. https://doi.org/10.1016/j.cie.2020.106889

JOURNAL OF ARCHITECTURE, PLANNING & CONSTRUCTION MANAGEMENT
Volume 14 Issue 2, 2024 E-ISSN: 2462-2222 ISSN: 2231-9514

COMMUNITY FISH MARKETS: DESIGN STRATEGIES FOR IMPROVED FUNCTIONALITY AND USER EXPERIENCE

Received: 20 September 2024 | Accepted: 04 December 2024 | Available Online: 07 December 2024
DOI: 10.31436/japcm.v14i2.934

Aina Shafira Basir [1], Nayeem Asif[2*], Zeenat Begam Bt Yusof [3], Aliyah Nur Zafirah Sanusi[4]

[1] Department of Architecture, Kulliyyah of Architecture and Environmental Design, IIUM, Malaysia Email: ainashafirabasir@gmail.com

[2] Department of Architecture, Kulliyyah of Architecture and Environmental Design, IIUM, Malaysia Email: nayeem@iium.edu.my*

[3] Department of Architecture, Kulliyyah of Architecture and Environmental Design, IIUM, Malaysia Email: zeensoni@iium.edu.my

[4] Department of Architecture, Kulliyyah of Architecture and Environmental Design, IIUM, Malaysia Email: Design, IIUM, Malaysia Email: aliyah@iium.edu.my

Corresponding author: **Nayeem Asif*
Corresponding author's email: nayeem@iium.edu.my

ABSTRACT

Addressing the design issues of community fish markets involves making necessary changes to meet contemporary preferences. This research aims to identify and address issues related to design and layout efficiency, cleanliness, and accessibility to propose viable recommendations that improve the overall functionality and user experience of community fish markets. The study focused on two case studies for primary data collection: Sungai Udang Fish Market and Sungai Batu Fish Market. Data collection methods included visual observation and a questionnaire survey, with descriptive analysis performed based on the results of these observations and surveys. Major findings recommend that the design prioritise spatial efficiency, cleanliness, and safety to create a welcoming and functional fish market. The layout should be optimised for user needs, and adequate waste management and sanitation infrastructure should be implemented to maintain a hygienic environment. Effective design strategies and improvements in facilities will not only elevate the user experience but also contribute positively to the economic growth and development of the fishery sector in Malaysia. Future research can consider the design of contemporary fish markets that cater to the needs of urban populations within urban centres in Malaysia.

Keywords: Fish Market, Cleanliness, Sg. Udang, Sg. Batu. Pasar Nelayan

1.0 INTRODUCTION

A fish market is typically where fresh products, such as fish, can be purchased reasonably. Fish markets are present in industrialised and developing countries, though they are more common in the latter. Millions rely on fish markets for economic growth and survival, including smallholder farming households, traders, vendors, and consumers. The sights and sounds of a community fish market contribute to the rich tapestry of community life. According to the Southeast Asian Fisheries Development Center (SEAFDEC) report, marine capture fisheries were the main contributors to fish production and the economy of Malaysia in 2016, with 1,574,447 metric tons valued at US$2.5 million and employing 132,305 people. (Omar, 2018)

Lin et al. (2021) highlight that wet markets are crucial for consumers, vendors, and sellers

within the retail food supply chain. (Lin et al., 2021). A well-planned fish market with multifunctional infrastructure and facilities—such as spaces for weighing, transport, and storage—is essential to ensure the quality of fish and attract more buyers. Thus, this research aims to redesign the infrastructure and facilities of fish markets to improve user efficiency.
Moreover, a significant challenge in this research is the need for more awareness regarding cleanliness and sustainability within fish market environments. Issues such as improper garbage disposal and dirty water can harm the environment. (Sarry et al., 2023). Both market managers and fish sellers need to be educated on maintaining sanitary and hygienic conditions for handling fish. The fish market must be kept clean and tidy, as a dirty environment deters visitors and reflects poorly on the community. Unsanitary conditions and inadequate environmental management risk public health and prevent all generations in the community from fully appreciating the distinctive characteristics of the fish market. (Rasmiya Begum et al., 2024).

The Culture of Fishing in Malaysia

The history of fishing villages in Malaysia began in earnest in the late eighteenth century. According to Gin (2015), Penang became a melting pot of various ethnicities and religious affiliations due to Francis Light's policy of allowing merchants to trade without paying taxes or duties. This led to an influx of immigrants from different parts of Asia. Each ethnic community tended to specialise in various trades and economic sectors. At that time, agricultural occupations, such as rice farming and coastal fishing, were primarily undertaken by ethnic Malays (Gin, 2015). As these communities established themselves in specific areas with particular occupations, settlements began to form, marking the origin of fishing villages.

Fig. 1: Fish Market or *Pasar Nelayan,* a part and parcel of Malaysian village lifestyle.
(Source: https://www.utusan.com.my/berita/2023/06/ikan-rakyat-naik-di-pulau-pinang-negeri-sembilan-kelantan-turun/)

In Malaysia, fishermen typically set out to sea in the early morning, between 3 a.m. and 4 a.m., and return to their villages late after spending approximately four hours at sea. Upon returning, they head directly to the wet market to sell their catch until the lunch hour. Traditional fishing villages in Malaysia are predominantly located along the east and west coasts of Peninsular Malaysia. Ninety-seven per cent of households in these fishing villages are involved in fishing. (Tietze, 2003)

Community Fish Market

A community fish market is a vital hub for the distribution of daily necessities, where people of a particular community gather each day to purchase fresh fish directly from the sea. It has historically served as an open and vibrant environment, facilitating the daily fish trade and expanding other local trades. The community fish market is a significant city icon, attracting tourists with its lively atmosphere. According to Bentley (2016), community fish markets function as social centres within villages or urban squares, enhancing the community's potential to flourish. They provide a space for people to converse with neighbours, interact with vendors, and meet new individuals. (Bentley, 2016)

As a public space, a community fish market is accessible to individuals of all backgrounds without imposing dress codes, unlike more restricted areas such as schools or offices. This inclusive nature supports various activities, including selling, sorting, packaging, storing, and transporting fish. These activities are essential community components and contribute to the market's dynamic environment. Moreover, community fish markets can highlight and preserve local cultural aspects, making them a valuable asset for attracting tourists to the city. (Hendriks, 2022)

Efroymson et al. (2009) describe public space as a realm where people enjoy freedom of action and access. (Efroymson et al., 2009). From a design perspective, such spaces' quality is often measured by how well the design meets user expectations. (Power & Dalgleish, 2008). Therefore, the design of community fish markets should be responsive to the needs and preferences of users while maintaining operational efficiency. This approach will help ensure that the fish market remains a functional and engaging public space.

2.0 ISSUES RELATED TO THE DESIGN OF COMMUNITY FISH MARKETS

Addressing the design issues of community fish markets involves making necessary changes to meet contemporary preferences. This includes enhancing design approaches and strategies and focusing on cleanliness and hygiene to ensure a positive user experience. Furthermore, inadequate facilities impact sellers and users, affecting accessibility, safety, and overall market experience.

Fig. 2: The loading bay of the fish market Sungai Udang:

According to Tracy-White (1995) and Thomas (2019), vendors should be organised based on their activities and commonalities. (Thomas, 2019; Tracey-White, 1995). However, many community fish markets need proper circulation, which hampers movement between vendors. Studies emphasise the need for updated facilities and design components in loading bay to improve fish handling operations and overall efficiency (Lau & Ghazali, 2021). This issue is evident in the Sungai Udang, Penang fish market, where an unplanned loading bay and narrow walkways restrict user movement, accommodating only one person at a time (Figure 2). Consequently, navigating the market becomes challenging, especially during peak hours when the market is crowded.

Fig. 3: The exterior of the fish market of Sungai Batu.

Another challenge in this research is the need for more awareness regarding the cleanliness and sustainability of fish market operations. For example, improper waste disposal, including managing fish residues and cleaning practices in selling areas, can harm the environment. The unloading areas, often cluttered with fish boxes, also require attention. Enhancing these areas is crucial for maintaining hygiene and improving the efficiency of retail space utilisation. (Permatananda et al., 2022). Effective fish market enhancement programs can positively impact the community by improving market efficiency, protecting health, and enhancing market amenities and aesthetics.

The SEAFDEC Annual Report 2023 highlights the critical need for improving fishery hygiene and quality management systems to promote sustainability and enhance product standards across the supply chain. This study aligns with these objectives by addressing cleanliness, efficiency, and operational improvements in community fish markets, fostering a more sustainable and functional environment for stakeholders. (Southeast Asian Fisheries Development Center (SEAFDEC), 2024)

This research aims to identify and address issues of design and layout efficiency, cleanliness, and accessibility and propose viable recommendations that improve the overall functionality and user experience of community fish markets.

3.0 METHODOLOGY

The research focused on two case studies for primary data collection: Sungai Udang Fish Market and Sungai Batu Fish Market. Both are traditional community fish markets located in Penang State, Peninsular Malaysia. These case studies were selected based on their historical presence within their respective communities. The studies provide strong evidence of traditional practices in designing and operating community fish markets in Peninsular Malaysia.

Selection of case studies

Sungai Udang's fish market is in a small village deep inside Nibong Tebal, which is the heart of Kampung Sungai Udang. According to *Malay Mail,* "The village has been around for at least 60 years or more; the row of tired-looking wooden houses interspersed with more modern brick ones lining the street speak of the humble beginnings of this village." (Mok, 2016). This indicates that the community established the village near the inshore fish market primarily to supply fish to the community, making it a significant source of income. Sungai Batu's fish market is located in the Southwest District of Penang Island (Figure 3). According to a fisherman from Sungai Batu, the site is protected from the monsoon season, allowing them to venture out to sea without fear. This is due to a protected harbour near the island's southern extremity, where fishermen can safely bring in their catches, shielded from adverse weather conditions.

Data collection and analysis

Data collection methods included visual observation based on predefined elements: Site Location and Zoning, Building Layout and Spaces, Building Material, Circulation Spaces and Loading Areas, and Parking Facilities. Additionally, a questionnaire survey was conducted with 40 respondents from both case studies. The survey targeted community members who are regular users of the fish markets through a simple random sampling method.

Data analysis was performed descriptively based on the results of the observations and surveys. Recommendations were developed focusing on three distinct aspects of community fish markets:

1) Spatial Design and Layout,
2) Cleanliness and Hygiene, and
3) Accessibility and Safety.

These recommendations are intended to guide the basic design considerations for future community fish markets, ensuring they address the needs and preferences of local users.

4.0 RESULTS AND DISCUSSION

4.1 Visual Observation

Based on the literature review, the following five elements have been observed to compare the selected case studies of the fish market in Sungai Udang and Sungai Batu in Penang, Malaysia.

1. Site Location and zoning

Both sites are located inshore, which is beneficial for maintaining the freshness of the fish, ensuring it reaches buyers directly. Additionally, their proximity to residential areas makes it convenient for the local community. The site zoning in Sungai Udang is more compact, with the market surrounded by shophouses and residences, giving it a busier, more congested appearance. In contrast, the site zoning in Sungai Batu is clearer, as it follows a linear organisation, making it easier to see and access the market areas (Figure 4).

Fig. 4: Location and zoning of fish Market at Sungai Udang (left) and Sungai Batu (right)

2. Building Layout and spaces

The fish markets at Sungai Udang and Sungai Batu differ in their spatial organisation, with Sungai Udang following a centralised layout and Sungai Batu having a linear organisation. Both markets should improve their space planning and circulation to enhance user comfort and safety. The key spaces in both markets include the fish market, loading bay, storage area, offices, and food stalls. However, the spaces at Sungai Udang are more congested and less organised compared to the more linear and user-friendly layout of Sungai Batu. Both markets would benefit from proper storage facilities to prevent fish boxes from being left nearby. This would also help maintain cleanliness and create a better impression for the community and tourists.

3. Building Material

The Sungai Udang fish market primarily uses timber, with some newer extension areas constructed from bricks. In contrast, the Sungai Batu fish market uses conventional concrete columns and features a ceramic tile roof (Figure 5).

Fig. 5: Building material of fish Market at Sungai Udang (left) and Sungai Batu (right)

Both types of materials, however, are susceptible to deterioration over time due to the high moisture levels in the riverside environment, necessitating regular maintenance to ensure their longevity and functionality.

4. Circulation Spaces and loading area

Regarding circulation, the Sungai Udang fish market needs proper organisation compared to Sungai Batu. At Sungai Batu, the selling area is located at the front of the market and separated from the loading area, allowing for smoother traffic flow. In contrast, at Sungai Udang, the selling area is combined with the loading area, resulting in poor circulation and congestion within the market.

In the loading and service area at Sungai Udang, the loading space is attached between the fish landing jetty and the market itself. Located at the back of the market, the loading process involves hand-carrying the fish, with the fishermen directly selling their catches in the market. On the other hand, at Sungai Batu, the loading area is detached from the fish landing jetty but still located at the back of the market. The process also involves hand-carrying the fish, but someone other than the fishermen sell the fish inside the market.

Both markets need help with the attached loading areas, making the market feel packed and uncomfortable (Figure 6). The spaces for loading and selling should be larger and better organised to ensure smoother operations. The chaotic situation caused by fishermen unloading fish and buyers crowding around the same area highlights the need for better spatial planning to avoid disruption and improve user experience.

Fig. 6: Circulation and loading area of fish Market at Sungai Udang (left) and Sungai Batu (right), Penang, Malaysia

5. Parking Facilities

Due to insufficient and improper parking facilities for fish market users, all vehicles are parked along the side of the road. This lack of designated parking spaces leads to traffic congestion in the morning, as most people come to buy fish during that time, exacerbating the situation (Figure 7).

Fig. 7: Roadside informal parking area of fish Market at Sungai Udang (left) and Sungai Batu (right), Penang, Malaysia

Unhindered accessibility for the local community should be a priority in future developments of the fish markets, supporting fishermen and bolstering the local economy. Both the Sungai Udang and Sungai Batu fish markets would benefit from better spatial planning to effectively separate selling and loading areas, enhancing operational efficiency and user experience. Additionally, improved storage facilities are essential for maintaining cleanliness and creating a positive impression for visitors. Larger and more organised loading and parking areas are crucial to address congestion and facilitate smoother market operations.

Table 1: Comparative analysis of the study cases

Comparison factors	Sungai Udang Fish Market	Sungai Batu Fish Market	Remarks
Location and zoning	• Overlapping of functions • Buying and selling areas are scattered	• Proper demarcation of different functional spaces	• Proper zoning preferred for better visibility and functionality • Designated functional area enhance the overall experience
Organization and layout	• Centralized organization • Congested layout • Lack of proper storage spaces	• Linear organization • User friendly layout, easy to navigate • Lack of proper storage spaces	• Linear organization preferred for ease of circulation and less congestion. • Proper storage space helps in maintenance and cleanliness
Building material	• Primarily timber • Decayed due to lack of maintenance and moisture.	• Masonry structure with ceramic tiles roofing • Relatively good condition than timber structure	• Recommended to use materials less prone to decay, i.e., light weight metal, composite material, vinyl (PVC) etc.
Circulation Spaces and loading area	• Inadequate length of jetty • Overlapping of user circulation and service circulation • Less efficient and difficult to maintain cleanliness	• Extended jetty capable of accommodating large number of boats • Buying and selling area and service areas are separated	• Extended jetty offers better solution to boat congestion during the peak hours of the market • Loading area and buying and selling area should be separated • The loading area should have safe accessibility and adequate size
Parking facilities	• Lack of proper parking resulting traffic congestion	• Lack of proper parking resulting traffic congestion	• Adequate parking facilities should be provided • Balanced number of motorcycle and cars is required • Designated parking for large vehicles

The table above summarises the comparative analysis of the two case studies based on visual observation.

4.2 Users' perception of the markets' spatial design and environment

The following discussion illustrates the summary of the data collection of respondents for both case studies based on the questionnaire survey. Total number of respondents for both case studies was n=40.

1. Design and layout of the fish market

Based on observations of the Sungai Udang community, most residents are 50 and above. Many are retirees or full-time homemakers. As a result, they visit the fish market more than 11 times a month, with some going daily to get fresh fish. In contrast, the community at Sungai Batu consists mostly of working people with families. They visit the fish market less frequently but still buy fresh fish (Figure 8).

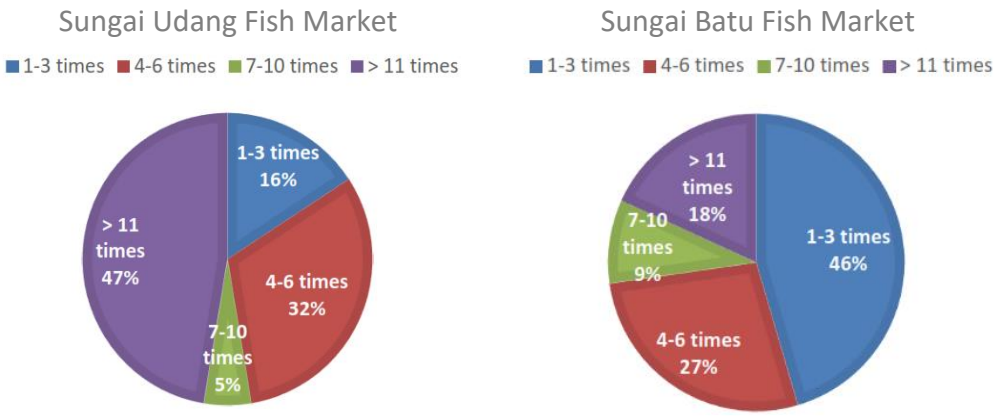

Fig. 8: Frequency of visiting the market

Shophouses and small homes surround the Sungai Udang fish market, so most users travel by motorcycle. In Sungai Batu, users either walk or use motorcycles, as the fish market is located near the residential area.

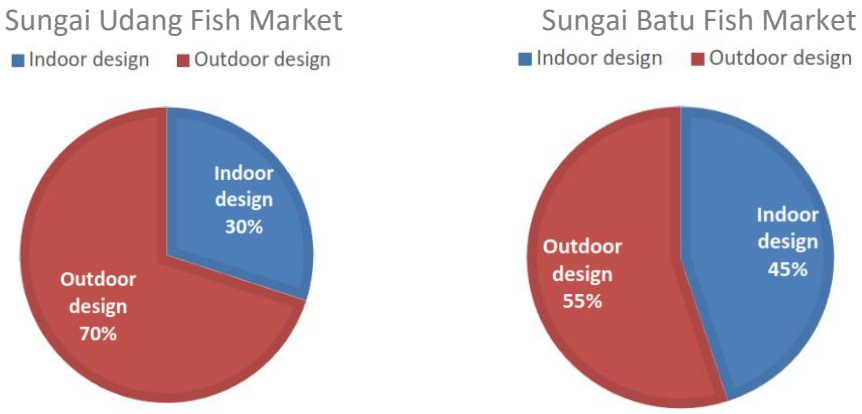

Fig. 9: Preference on the spatial design

Additionally, most market users prefer an open-air design (Figure 9). They are familiar with the concept and find it more comfortable, as the natural air and ventilation can easily circulate

through the market. One user noted that better natural ventilation makes an open-air fish market more comfortable. Moreover, both sites are located along the inshore area of the river, where the sea breeze provides additional comfort.

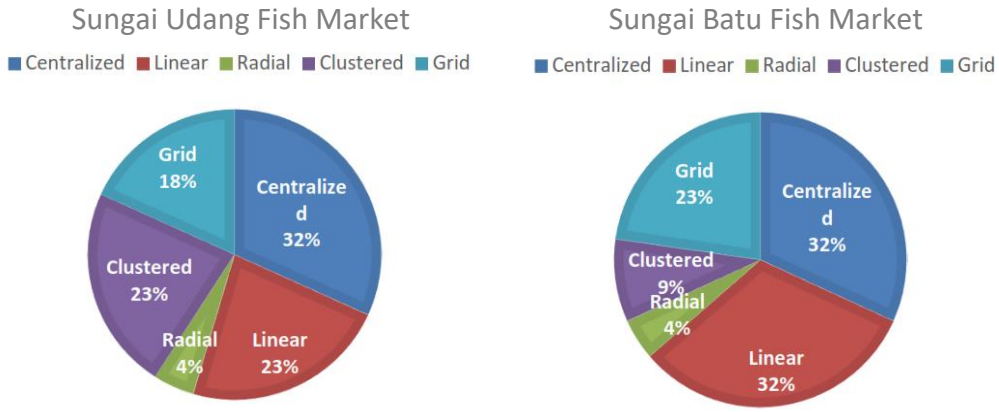

Fig. 10: Preference on the spatial layout

The layout of the fish market is also important, as it controls the flow of people, services, and the management of the market. Fish markets are processing facilities that must follow a particular sequence of operations. According to Ching's (2023) description, a linear organisation is ideal for such processes. (Ching, 2023). Based on the questionnaire survey, most users prefer a linear or centralised layout for the fish market, as it is easier to navigate (Figure 10).

2. Cleanliness and hygiene

In addition to spatial design and layout, cleanliness and hygiene must be addressed. Ensuring public health at the fish market is challenging due to inadequate measures for maintaining cleanliness and hygiene. As observed, the market design and layout contribute to difficulties in managing waste and preventing contamination. The close proximity of selling and loading areas and insufficient storage facilities exacerbates these issues.

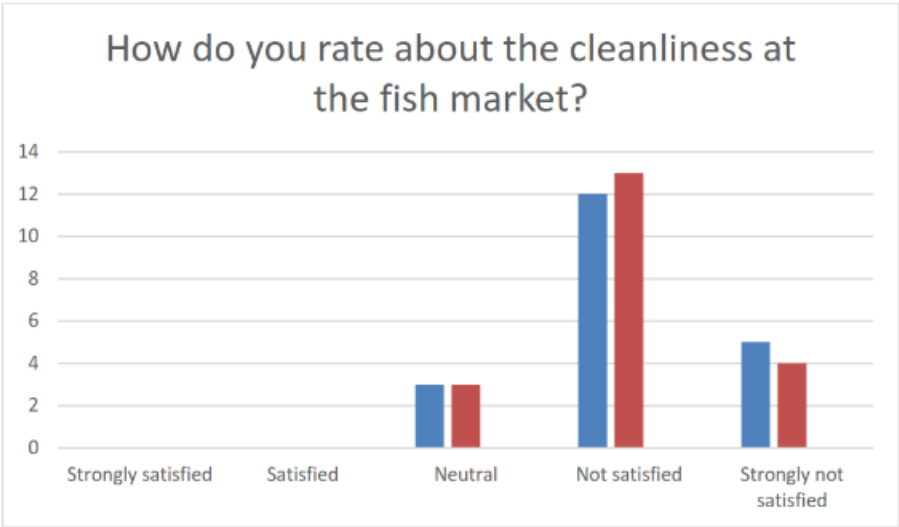

Fig. 11: Satisfaction rating on the cleanliness (Blue: Sungai Udang fish market, Red: Sungai Batu fish market)

As a result, it is not easy to guarantee that the food sold is consistently safe, clean, and in proper condition. The lack of proper sanitation infrastructure and management further increases the risk of foodborne illnesses, highlighting the urgent need for improved design and maintenance practices to protect public health. There is a serious risk to public health, as evidenced by users' dissatisfaction with the cleanliness at both markets. 25 out of 40 respondents (62.5 %) rated it as not satisfactory, and 9 out of 40 respondents (22.5 %) were strongly not satisfied when asked about the cleanliness and hygiene of the existing fish markets (Figure 11). This issue must be addressed by designing an effective flow, layout, and spaces to improve overall hygiene and safety.

3. Accessibility and safety

The questionnaire survey from the Sungai Udang and Sungai Batu communities found that both groups expressed dissatisfaction with the accessibility and safety of the fish markets. Twenty-six out of 40 respondents (65 %) were unsatisfied, and seven out of 40 respondents (17.5 %) were strongly dissatisfied, as there is no formal drop-off zone or parking space.

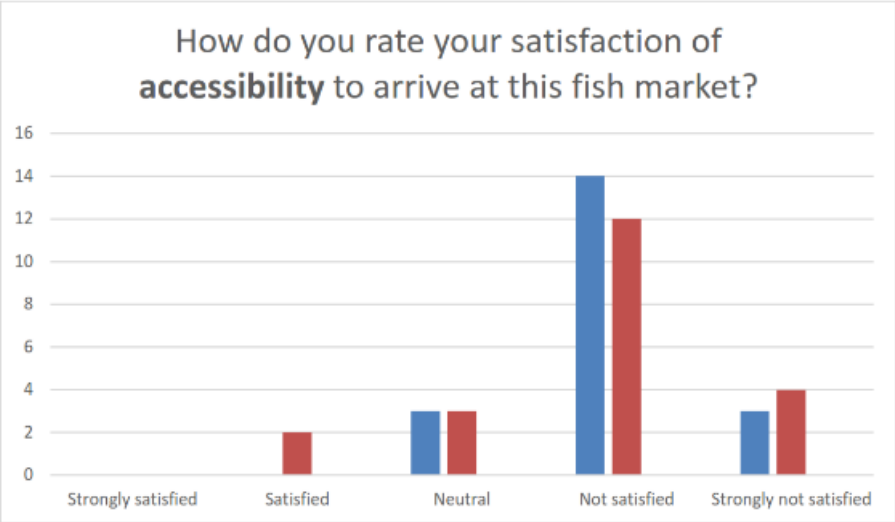

Fig. 12: Satisfaction rating on the accessibility (Blue: Sungai Udang fish market, Red: Sungai Batu fish market)

The lack of proper accessibility creates congestion, as users cannot navigate the market efficiently. This overcrowding exacerbates circulation problems, making it difficult for users to move between vendors due to the narrow walkways. The walkways need to be bigger, accommodating only one person at a time, which becomes particularly problematic during peak times, such as in the morning when the market is crowded. These issues not only hinder user movement but also raise safety concerns, as the congested conditions increase the risk of accidents and make it challenging for users to manoeuvre through the market.

Both case studies reveal that users are unsatisfied with the current conditions of the fish markets, indicating significant room for improvement in planning, maintenance, and operations (Figure 12). Enhancing these markets' overall design, layout, circulation, and maintenance can significantly improve user experience. These improvements will help ensure that traditional fish markets in Malaysia continue to thrive, support the local communities financially, and preserve their way of life.

5.0 RECOMMENDATIONS

Spatial Design and Layout

The layout of a community fish market should be optimised based on user needs and preferences, ensuring smooth operations from unloading to auctioning, storage, and selling fish. For small-scale community fish markets, it is necessary to consider implementing a linear layout to streamline these processes and improve navigation. Increase the width of walkways to accommodate the flow of multiple users simultaneously, especially during peak times. This will reduce crowding and enhance user movement efficiency.

There should be a clear separation between the buying and selling and service zones. The service zones can be divided into the loading area from the jetty to the storage spaces, selling stalls, and the fish processing area for shipment or selling. Among the primary zones of a community fish market are the service zone, buying and selling zone, admin zone, and ancillary facilities zone, such as restrooms, storage space and restaurants. Additionally, there should be ample parking space to avoid congestion during peak hours. Shared parking with adjacent facilities managed by time zoning can help reduce the land area requirement for parking facilities.

Cleanliness and Hygiene

Community fish markets should have dedicated waste disposal and cleaning areas to manage waste effectively and prevent contamination. Proper sanitation infrastructure is needed to support regular cleaning and maintain market hygiene. Adequate storage solutions to keep fish boxes and other materials off the market floor will ease maintenance. This will also help maintain cleanliness, reduce clutter, and ensure that the food sold is consistently safe and in proper condition.

Accessibility and Safety

Formal drop-off and parking zones are required to reduce congestion and facilitate smoother access. Analysing and improving road linkages to attract customers, easing transportation of fish products, and enhancing overall market accessibility are highly recommended for community fish markets. Implementing clear signage and safety barriers will guide user movement and prevent accidents. Designing pathways to be well-lit and unobstructed, with a clear separation between transport infrastructure and market areas, will ensure user safety.

6.0 CONCLUSION

One important factor that makes a place special is its community. Addressing the fishing sector is vital to improving Malaysia’s economy and community well-being, as it significantly contributes to the nation's economy. The study’s findings highlight that effective design strategies and improved facilities in community fish markets can enhance spatial efficiency, cleanliness, and safety, creating a welcoming and functional environment. Optimising the layout for user needs and implementing robust waste management and sanitation infrastructure are essential to maintain hygiene and user satisfaction.

The study also revealed that most respondents were dissatisfied with the current fish markets in Penang, Malaysia, emphasising the urgent need to address deficiencies in user requirements and cleanliness. Implementing the recommended improvements could

advance the economy and the fisheries industry, benefiting communities and the nation. Future research could explore contemporary fish market designs catering to urban populations to elevate user experience and economic potential further.

ACKNOWLEDGMENTS

This paper is based on research conducted for a Master's dissertation by the first author. The researcher fully funded the costs associated with this research.

REFERENCES

Bentley, K. J. (2016). *Modern Public Market to Revitalize a Small Community* (Issue 10125621). The George Washington University.

Ching, F. D. K. (2023). *Architecture: Form, Space, and Order* (5th ed.). Wiley. https://www.wiley.com/en-ca/Architecture%3A+Form%2C+Space%2C+and+Order%2C+5th+Edition-p-9781119853381

Efroymson, D., Thi, T., Thanh, K., Pham, H., Ha, T., & Jones, L. (2009). *Public Spaces: How They Humanize Cities*. https://healthbridge.ca/dist/library/Public_Spaces_How_they_Humanize_Cities.pdf

Gin, O. K. (2015). *DISPARATE IDENTITIES: PENANG FROM A HISTORICAL PERSPECTIVE, 1780-1941*. *33*(2), 27–52. http://web.usm.my/km/33(Supp.2)2015/km33s22015_03.pdf

Hendriks, S. L. (2022). Sustainable small-scale fisheries can help people and the planet. *Nature*. https://www.nature.com/articles/d41586-022-01683-2

Lau, Z. Y., & Ghazali, A. (2021). A study on the design strategies of Fish Landing Jetty Complexes in Malaysia to enhance the efficiency of the building. *IOP Conference Series: Earth and Environmental Science*, *881*(1), 012049. https://doi.org/10.1088/1755-1315/881/1/012049

Lin, B., Dietrich, M. L., Senior, R. A., & Wilcove, D. S. (2021). A better classification of wet markets is key to safeguarding human health and biodiversity. *The Lancet Planetary Health*, *5*(6), e386–e394. https://doi.org/10.1016/S2542-5196(21)00112-1

Mok, O. (2016). *For the day's catch, take a trip to this little fishing village in Nibong Tebal*. https://www.malaymail.com/news/eat/drink/2016/05/01/for-the-catch-of-the-day-take-a-trip-to-this-little-fishing-village-in-nibo/1110391

Omar, A. F. M. (2018). *Fisheries Country Profile: Malaysia (2018)*. The Southeast Asian Fisheries Development Center (SEAFDEC). http://www.seafdec.org/fisheries-country-profile-malaysia-2018/

Permatananda, P. A. N. K., Pandit, I. G. S., & Cahyawati, P. N. (2022). Improve Hygiene and Sanitation in Fish Traders Group of Kedonganan Fish Market Toward Healthy Market. *Mattawang: Jurnal Pengabdian Masyarakat*, *3*(4), 399–403. https://doi.org/10.35877/454RI.mattawang1184

Power, M. J., & Dalgleish, T. (2008). *Cognition and Emotion: From Order to Disorder*. Psychology Press. https://books.google.com.my/books?id=xhNHJ32yN1gC

Rasmiya Begum, S. L., Himaya, S. M. M. S., Imthiyas, M. S. M., & Afreen, S. M. M. S. (2024). *Fish Waste: Understanding the Pollution Potential and Sustainable Mitigation Strategies* (pp. 427–440). https://doi.org/10.1007/978-981-99-8593-7_20

Sarry, A., Budhi, S. T. E., & Setiawati, T. S. (2023). *Environmental sanitation at the fish market (studies in Pasar Ikan Modern, Muara Baru)*. 030038. https://doi.org/10.1063/5.0127562

Southeast Asian Fisheries Development Center (SEAFDEC). (2024). *SEAFDEC Annual Report 2023*. Southeast Asian Fisheries Development Center. https://repository.seafdec.org/handle/20.500.12066/7495

Thomas, J. W. (2019). *Market Segmentation*. https://www.decisionanalyst.com/whitepapers/marketsegmentation/

Tietze, U. (2003). *Microfinance in Fisheries and Aquaculture: Guidelines and Case Studies*. Food and Agriculture Organization of the United Nations (FAO).

Tracey-White, J. D. (1995). *Retail Markets Planning Guide*. Food and Agriculture Organization of the United Nations. https://books.google.com.my/books?id=56W9jgEACAAJ

JOURNAL OF ARCHITECTURE, PLANNING & CONSTRUCTION MANAGEMENT
Volume 14 Issue 2, 2024 E-ISSN: 2462-2222 ISSN: 2231-9514

THE PROFILING OF AL-ROZNAH IN OMANI INTERIOR DESIGN: FROM CULTURAL IDENTITY TO CONTEMPORARY LOSS AND REINTERPRETATION

Received: 16 Dec 2024 | Accepted: 05 Jan 2025 | Available Online: 20 Feb 2025
DOI: 10.31436/japcm.v14i2.941

Hadifi Wafaa Awadh Hamdan[1], Arita Hanim Awang[2*]

[1] Department of Architecture, Kulliyyah of Architecture and Environmental Design, International Islamic University Malaysia*
[2] Department of Applied Arts and Design, Kulliyyah of Architecture and Environmental Design, International Islamic University Malaysia

**Corresponding Author: Arita Hanim Awang*

The corresponding author's email: aritahanim@iium.edu.my

ABSTRACT

This study examines the evolution of Al-Roznah, a traditional architectural element in Omani's interior design. It has multifunctional elements, blending aesthetics and practicality. The research further explored the cultural significance, the functional role and the decline of Al-Roznah in contemporary interiors. A qualitative method was employed, and semi-structured interviews were conducted. The fieldwork was conducted in four (4) historical neighbourhoods in Al-Dakhiliyah Governorate, documenting variations in Al-Roznah's design, materials, and uses. The findings have shown the shifting role from a symbol of Omani cultural identity to primarily decorative features due to several factors. Thus, the article highlighted the efforts for Al-Roznah's restoration of traditional values into contemporary interior design for future generations.

Keywords: Al-Roznah, Omani interior design, wall cavities, Omani Heritage, Traditional elements.

1.0 INTRODUCTION

Traditional architectural elements are integral design features preserving cultural identity, serving as vessels of historical, social, and aesthetic significance. The Al-Roznah, specifically in Oman, is a wall cavity, distinctive by its geometrical shapes, pointed arches, rounded ends, and intricate wooden or stone shelves. It symbolises the connection between form, function, and heritage (Al-Kalbani et al., 2018). In the past, Al-Roznah is used for practical and decorative purposes. It also offers storage solutions while enhancing the interior design of Omani homes. However, in contemporary architectural practices, such traditional features face challenges, from functional redundancy to loss of cultural significance.

The transition from traditional to modern design has sparked concerns about the "contemporary loss" of Al-Roznah as its role evolves or diminishes in Omani interiors. Modern lifestyles, urbanisation, and changing aesthetic preferences have contributed to this phenomenon, where cultural elements are often overlooked or replaced by more generic, globalised design approaches (Al-Riyami, 2020). Despite such challenges, efforts to restore and reinterpret Al-Roznah within contemporary settings are emerging, aiming to create a balance and harmony between heritage preservation and modern functionality.

This article examines the evolution of Al-Roznah in Omani interior design, focusing on its journey from a cultural cornerstone to its modern reinterpretation. Through research, fieldwork, and case studies, it explores the challenges facing Al-Roznah, efforts to preserve its relevance, and its modern-day significance in Omani homes. Most of the residential

communities in Oman have similar elements. The facilities were mainly built from mud, stone for foundations, plaster and sand, and indoor windows and ceilings were constructed from local and imported wood (Sheikh, 2019). The article highlights the perspectives of Omani youth, the role of community spaces like mosques in preserving this tradition, and its adaptation in contemporary settings such as cafes and traditional inns.

This study contributes to the broader discourse on preserving architectural heritage in the face of globalisation and modernisation by profiling Al-Roznah's transformation and identifying strategies for integrating it into modern interior design. It highlights the need to maintain the cultural identity embedded in traditional elements while ensuring their relevance and appeal in today's dynamic design landscape.

2.0 LITERATURE REVIEW

The word 'Al-Roznah' is originally from Persia and means light or glow in the dialect of the Levant (Syria, Lebanon, Jordan, and Palestine).

2.1 Definition of Al-Roznah

The term Al-Roznah, also referred to as Al-Kuwa (النَّكوة) or "niche," is described in various Arabic dictionaries and literature. According to Mujahid (2018), the word "niche" originates from the language of Abyssinia, where it refers to a hollow space within a structure. Mujahid (2018) further elaborates that it was historically associated with ironwork, where lamps were attached, and the wick was placed within the niche. Similarly, it has been described as a hollow space in the wall, not functioning as a window but often used for placing lamps (Niche, n.d.). Qudamaa (2017) notes that niches were sometimes round or oval and served dual purposes, such as ventilation and lighting, as well as for defence, allowing for strategic placement within walls. Hejles (2019) characterises Al-Roznah as an interior wall feature consisting of shelves built into walls, forming recesses or voids that enhance functionality and aesthetics. These built-in cavities could be square, round, or oval, providing storage or decorative functions.

This comprehensive understanding underscores the multifaceted nature of Al-Roznah, which blends functional utility, aesthetic design, and cultural heritage within traditional Arabic architecture.

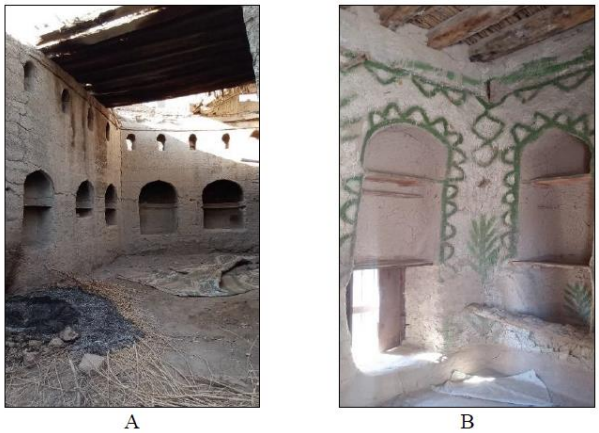

Fig. 1: Al-Roznah with the different Arches in Harat AL Aqr in Bahla, Oman
(Source: Author, 2023)

Al-Roznah designs are illustrated in Fig.1, featuring distinct wall cavities observed in Harat Al Aqr, Bahla, Oman. These niches are characterised by pointed arches, rounded ends, and geometric patterns, showcasing the traditional craftsmanship of Omani architecture. Al-Roznahs, in this context, serve both functional and decorative purposes, acting as built-in wall cavities for storage or display. Using locally sourced materials such as mud and stone emphasises their integration into the thick walls of traditional homes, reflecting the resourcefulness and aesthetic sensibilities of the era. This diversity in arch design highlights the adaptability of Al-Roznah to different architectural styles within the region, preserving its cultural and functional significance.

2.2 Omani Al-Roznah

The material culture of Oman is prosperous and varied, and it can be dealt with comprehensively. To understand a culture, one has to look at the integration of history, including architecture and art. Traditional Omani architecture has a wonderfully sensitive appreciation of the natural environment's materials and colours (Hegazy (2014). The human-scale buildings have some of the most distinctive architectural features, such as carved wooden doors with chiselled geometric or floral patterns; carved window screens; mud, lime plaster and stucco work Al-Salmi et al.,(2008), and also the Al-Roznah.

Thousands of forts, souks (also known as bazaars), and ancient monuments fascinate travellers with the presence of the Sultanate's ancient traditions. Some aspects of Omani architecture, such as doors, windows, and historical wall openings, show the nation's connection to its heritage. These architectural features are often found in heritage sites and museums. Doors, windows, and Al-Roznahs were among the most important forms of decorative expression in traditional Omani buildings, David (2020).

In the past, these items were considered symbols of status and hospitality. These elements often take the form of inscriptions from traditional arts, such as arches, windows, and niches, and are often engraved with verses of the Qur'an. The frames and details of old wooden doors and windows and handcrafted wall openings are usually decorated in bright colours (Al-Salmi et al., 2008).

As mentioned previously, Al-Roznah is usually a non-window interior wall opening in the form of cavities or voids in the internal walls of a room. The Al-Roznah may be designed with built-in wall shelves made of either wood or either wall material. It could be built on the ground level and up to the roof of the building, where the elevation of the Al-Roznah and the depth of its cavity varies inside the wall to its thickness (Zakaria, 2017). Al-Roznah displays crucial things such as clothes, lamps, weapons, books, and Al-Quran.

The Omani Al-Rwazin (plural of Al-Roznah) has similar shapes but with either curved arches or pointed arch tips. They varied between unilateral and bilateral and up to triple vertically or between stanchions and windows. The Omani architect added longitudinal frames carved with geometric and plant motifs, adding elegance and beauty to the Al-Roznah (Zakaria, 2017).

3.0 METHODOLOGY

This study employed a qualitative research design through semi-structured techniques such as focus group discussions and expert interviews. Other methods include observation and case studies (DeFranzo, 2011). According to Obidat (2000), gathering information regarding the current situation and its historical circumstances and identifying the influencing factors from past experiences is feasible. Additionally, the study investigates Al-Roznah as a critical element of Omani architectural heritage, from functional, aesthetic, and cultural significance.

3.1 Research Design

The case studies exploring Al-Roznah focus mainly on the context of four historical neighbourhoods (Harrahs) in the Al-Dakhiliyah Governorate of Oman. This method enables a detailed examination of Al-Roznah's architectural and cultural characteristics and variations across residential settings.

3.2 Data Collection Methods

3.2.1 Field Observations

Observations were conducted at the four selected Harrahs: Harrat Al-Bilad (Manah), Harrat Al-Aqar (Bahla), Harrat Al-Nizar (Izki), and Harrat Al-Khadeemah (Al Hamra). The selected Harrahs come from a region with nearly consistent weather, humidity, and temperature conditions, as well as agricultural areas and groundwater sources like wells and Aflaj (ancient Oman's irrigation systems) (Al Ghafri, 2018). Field notes and sketches were made during the observation process to document the dimensions, materials, and decorative patterns of Al-Roznah features within the houses. Additionally, digital photography was utilised to capture visual details of Al-Roznah structures, inscriptions, and motifs. Thus, Al-Roznah was photographed in several locations, and the images are crucial for documenting the data and explaining it systematically.

3.2.2 Measurements and Drawings

Two measuring tools were used to measure Al-Roznah. One is a steel-type measuring tape used in the most challenging and complex to-reach areas, especially the depth measurement, while the other is a flexible measuring tape. It measured the longest bars in a home whose floors and ceilings collapsed. In this study, Al-Roznah was physically measured (length, width, depth, and positioning) to understand its structural variations across different sites. The information was later transferred into AutoCAD software through field measures and sketches. This software refined and analysed the collected measurements, ensuring accuracy in representing the architectural details.

3.2.3 Semi-Structured Interviews

Interviews were conducted with local experts who lived in old Omani houses and personally used Al-Roznah. These experts also included artisans and long-term residents who possess knowledge of Al-Roznah's construction, functionality, and cultural significance. During the interviews, the participants will be introduced to the research topic and will be asked according to three research questions. The topics included historical uses, traditional construction methods, and perceptions of Al-Roznah in contemporary contexts.

3.2.4 Archival Research

Archival research involves authorities providing detailed information, especially from archival records. It usually involves primary research from the authorities concerned with restoring old Harrah and the Ministry of Heritage and Municipality. This method enables the researcher to trace the feature's development and role in Oman's architectural heritage. On the other hand, to place Al-Roznah within a larger cultural context, these comparative analyses were conducted with other traditional niches in neighbouring Gulf and African regions.

3.3 Data Analysis

3.3.1 Qualitative Content Analysis

Field notes, interview transcripts, and visual documentation were systematically coded and categorised to identify recurring themes and patterns. Key themes included functionality, aesthetics, preservation challenges, and reinterpretation in contemporary design.

3.3.2 Visual and Dimensional Analysis

Through fieldwork sketches, the drawing measurements were then transferred into AutoCAD. The software is used to produce precise 2D and 3D drawings and plans with exact measurements, thus allowing for a detailed understanding of the geometrical shape and spatial characteristics of Al-Roznah, particularly its structural integration within the thick walls of traditional Omani houses. It has been noted that the wall of the old Omani house is built from simple, local raw materials of clay and sand, has a substantial thickness of 50 cm and 80 cm and up to 1 meter and 1.5 meters. The wall’s thickness of 1.8 meters and 2 meters was also found.

The dimensions of the Al-Roznah vary significantly across regions; on average, the widths range from 40 to 95 cm, with a maximum of 1.5 meters, while the depths span from 30 cm to 1 meter. Heights start at 90 cm and reach up to 3 meters. Patterns and inscriptions were examined to explore their symbolic meanings and aesthetic contributions.

3.4 Study Scope and Limitations

The study focuses on the four Harrahs within the Al-Dakhiliyah Governorate. These Harrahs are listed as Harrah One (Harrat Al-Bilad in Manah), Harrah Two (Haarrat AL-Aqar in Bahla), Harrah Three (Harrat Al-Nizar in Izki), and Harrah Four (Harrat AL-Khadeemah in ALHamra). These sites are chosen for their historical significance and well-preserved architectural features. Limitations include access restrictions to specific sites and reliance on oral histories, which may introduce subjective interpretations. In addition, some of the Harrah was undergoing restoration works, which prevented the researchers from thoroughly investigating the Al-Roznah and everything associated with it. Despite such obstacles, the study helped disseminate a valuable contribution to documenting and preserving Omani architectural heritage.

4.0 RESULTS

This section explains the findings and analysis of the Al-Roznah evolution of Omani interior design. It emphasises transitioning from a functional and cultural feature to a contemporary reinterpretation. The study is structured into key themes supported by visual data, where applicable.

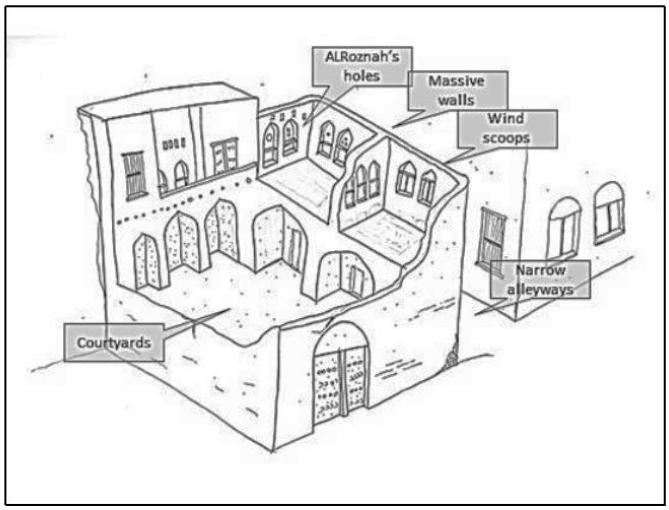

Fig 2: A section shows the wall thickness and Al-Roznah in an old Omani house
(Source: Author, 2023)

The figure (Fig 2) illustrates a cross-section of a traditional Omani house, highlighting two significant architectural features: the wall thickness and the Al-Roznah. The thick walls, characteristic of traditional Omani architecture, provide excellent thermal insulation by absorbing heat during the day and releasing it slowly at night, thus regulating indoor temperatures. The Al-Roznah, a small decorative opening, allows natural light and ventilation into the room, enhancing comfort while adding cultural aesthetic value.

4.1 Functional and Aesthetic Roles of Al-Roznah in Traditional Omani Interiors

Al-Roznah was traditionally used as both a functional and decorative element. It was initially designed for:

- **Storage**: Used for household items such as utensils, books, and personal belongings.
- **Display**: Showcasing decorative objects and religious artefacts.
- **Ventilation and Lighting**: Providing airflow and light in compact spaces without additional openings.

Fig 3: (From left) Women's beauty collectables and silver trays displayed in Al-Roznah
(Source: Author, 2022, 2023)

The figure (Fig 3) showcases a traditional Al-Roznah display featuring women's beauty collectables and silver trays. These elegantly arranged items reflect the region's cultural heritage and aesthetic preferences. The Al-Roznah, as a decorative element and a functional space for displaying valued possessions, underscores the blend of beauty and utility in traditional Omani interiors. Regarding aesthetics, Al-Roznah included pointed arches, carved wooden or stone shelves, and geometric shapes representing Omani artistry and cultural values.

Table 1: Functional and Aesthetic Roles of Al-Roznah in Traditional Omani Interiors

Feature	**Traditional Function**	**Aesthetic Characteristics**
Storage niches	Utility for everyday items	Minimalist, integrated within thick walls
Religious niches	Quran display in mosques	Elaborate carvings and inscriptions
Decorative wall features	Enhancing interiors	Geometric and floral motifs

Table 1 outlines the functional and aesthetic roles of the Al-Roznah in traditional Omani interiors. Storage niches within the Al-Roznah are typically minimalist and seamlessly integrated within thick walls, serving as practical spaces for everyday items. Religious niches, often found in mosques, display the Quran and feature elaborate carvings and inscriptions that reflect these spaces' cultural and spiritual significance. Additionally, the Al-Roznah includes decorative wall features that enhance the interiors with geometric and floral motifs, adding an artistic touch to the architecture.

4.2 Comparative Analysis: Traditional vs. Contemporary Al-Roznah

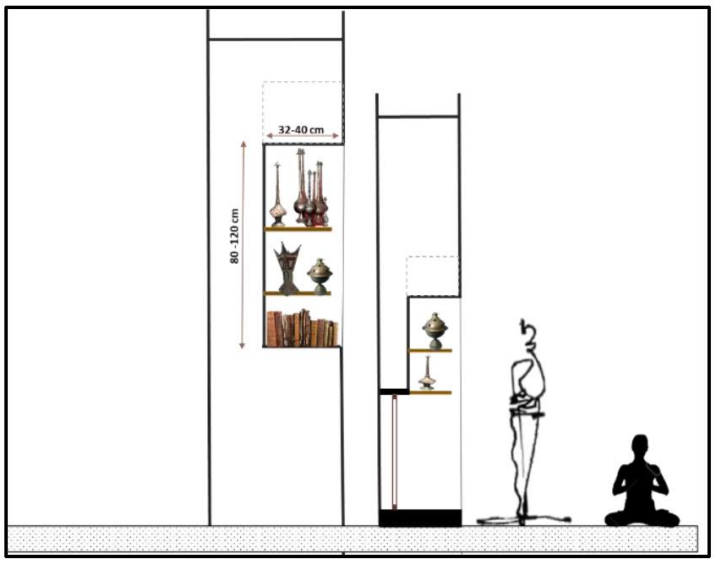

Fig 4: Section drawing of the Al-Roznah showing the aesthetic character in displaying antiques and possessions
(Source: Author, 2023)

Table 2 below compares Al-Roznah's traditional and modern applications. The comparisons are based on several key factors: design elements, material usage, functionality, aesthetic role, and cultural significance. The comparative analysis highlights Al-Roznah's transformation in response to modern interior design trends while considering its cultural heritage.

Table 2: Comparisons of traditional and modern applications of Al-Roznah

Aspect	**Traditional Al-Roznah**	**Contemporary Al-Roznah**
Design Features	Geometric patterns, pointed arches, and wooden/stone shelves.	Simplified forms, often with metal or plaster materials.
Materials	Local materials include mud brick, wood, and stone.	Modern materials like aluminium, plaster, and glass.
Functionality	Multifunctional: used for storage, display, and ventilation.	Primarily decorative, it is used in cafes, hotels, and commercial spaces.
Aesthetic Role	Integral to interior design, contributing to cultural identity.	Aesthetic features in modern spaces are often devoid of cultural context.
Cultural Significance	Strong cultural and symbolic importance linked to Omani heritage.	Limited cultural relevance is often seen as a design trend.
Placement in Spaces	Embedded in the architecture, it is integral to daily life in homes.	Added as an ornamental feature in contemporary settings.
Preservation and Restoration	Preserved through traditional restoration techniques.	Restoration often focuses on aesthetic preservation, losing traditional integrity.

Thus, due to the transition from one period to another, society has lost the culture of the Al-Roznah. Modern society merely thinks that the function of the Al-Roznah is limited to displaying antiques and possessions that reflect the material and social level and preserving the personal tools of the family members.

4.3 Decline in Contemporary Usage

With the modernisation of Omani homes, the practical need for Al-Roznah has gradually decreased. The functional role of Al-Roznah has also diminished, as it is now often relegated to decorative purposes in main halls, while bedrooms and kitchens opt for more contemporary fittings. Through observations, some modifications to the modern Al-Roznah are made. These modifications are as follows:

- **Replacement by Modern Furniture**: Cabinets and modular furniture have replaced the original storage function.

- **Shift in Material Use**: Different materials, such as plaster or aluminium, are used in modern adaptations, which compromises authenticity.
- **Functional Loss**: Often referred to decorative purposes in main halls, with bedrooms and kitchens opting for modern fittings.

(Table 3) below compares the traditional usage and modern adaptation of Al-Roznah in Omani homes. Traditionally, Al-Roznah served as a central storage feature in all rooms, constructed using materials like mud, stone, and wood, and was an integral part of the structural design. In modern adaptations, however, its role has been reduced to a decorative function, often limited to areas like main halls. The materials used have shifted to aluminium and plaster, compromising the authenticity of traditional designs.

Table 3: The comparison aspects between traditional usage and modern adaptation.

Aspect	Traditional Usage	Modern Adaptation
Storage	Central in all rooms	Limited to decorative function
Material	Mud, stone, and wood	Aluminium and plaster
Integration	Part of structural design	Add-on or symbolic feature

Additionally, Al-Roznah has become more of an add-on or symbolic feature rather than a functional part of the home's structure. Despite these changes, it remains a valued element, connecting contemporary interiors with traditional Omani heritage.

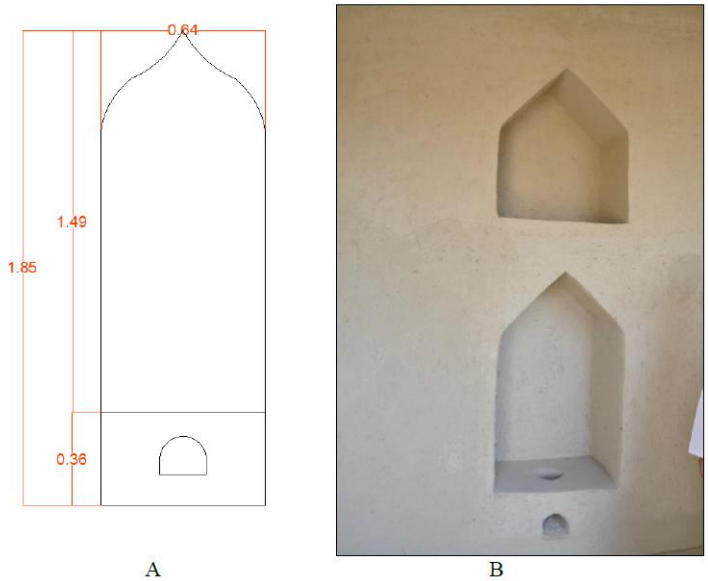

Fig 5: The dimensions of the cooking Al-Roznah stove at Harat ALBilad in Manah, Oman (2023) show that the stove's functions have evolved from decorative purposes.
(Source: Author, 2023)

Traditionally, the buildings were constructed with simple wood moulds, with stone added to strengthen their structure. Mud clay is the natural choice for constructing the Harrah and the Al-Roznah. However, in contemporary usage, the Al-Roznah has been modified and lost its original design, which depends on pointed arches and layers of shelves. It was built with

aluminium on the house and painted in wood. Thus this is due to the availability of different types of wood and the development of trade and industry, which eventually became feasible for everyone.

4.4 Preservation Efforts in Religious and Cultural Spaces

Mosques continue to preserve the traditional function of Al-Roznah. In these sacred spaces, the Al-Roznah often serves as a niche for displaying the Quran and holding other religious artefacts. Through observation, the preservation of Al-Roznah in religious and cultural spaces is as follows:

- **Quran Storage**: It is needed to maintain its original function in a religious context.
- **Symbolism**: It symbolises the nation's cultural identity and heritage.
- **Restoration Projects**: Restoration projects mainly focus on preserving traditional niches in historical and cultural settings.

Furthermore, environmental factors like humidity and material erosions frequently challenge the success of Al-Roznah's preservation initiatives.

4.5 Contemporary Reinterpretation in Hospitality and Heritage Spaces

Modern reinterpretations of Al-Roznah are prominent in the hospitality sector, especially in cafes, traditional inns, and cultural tourism spaces. The aesthetic of Al-Roznah was highlighted to reflect the Omani character, enhancing its value.

- **Lighting and Decor**: Al-Roznah is enhanced with lighting to emphasise its aesthetic value.
- **Cultural Branding**: Used as a symbol of Omani heritage to attract tourists.

This practice showcases the beauty of the Al-Roznah and serves as a decorative feature that enhances the space's overall ambience.

Table 4: The comparison aspects between traditional usage and modern adaptation.

Sector	Examples	Purpose
Hospitality	Cafes, inns	Cultural branding, heritage tourism
Public Spaces	Museums, Heritage centres	Education, cultural preservation

The comparisons in (Table 4) above show the traditional usage and modern adaptation of Al-Roznah across different sectors. In the hospitality sector, traditional Al-Roznahs are found in cafes and inns, serving purposes related to cultural branding and heritage tourism. These elements are used to enhance the cultural appeal of these establishments, attracting visitors who are interested in experiencing traditional architectural features. In public spaces such as museums and heritage centres, Al-Roznahs are preserved to serve educational purposes and cultural preservation.

5.0 CONCLUSION

The Al-Roznah, an essential feature of Omani architectural heritage, is proven to have functional and aesthetic importance. It embodies the intersection of cultural identity and functional design. Historically serving as a multifunctional element, Al-Roznah was integral to traditional Omani interiors, blending aesthetic appeal with practicality. However, its

significance has gradually declined from time to time and primarily acted as a decorative feature in contemporary modern spaces.

Despite these challenges, Al-Roznah remains a cultural icon, notably in religious and heritage-focused settings like mosques, traditional inns, and cafes. These issues must be dealt with care accordingly by the respective authorities, and the importance of community education in preserving the architectural heritage. In addition, it is essential to balance preservation with innovations, ensuring Al-Roznah elements are relevant in modern design practices while upholding their cultural essence.

6.0 RECOMMENDATIONS FOR FUTURE RESEARCH

Further recommendations include researching the historical variations of Al-Roznah across Oman and documenting regional differences and their cultural implications. Researchers could also explore the psychological and social impact of Al-Roznah as a cultural element in modern interiors, particularly its influence on identity and well-being.

ACKNOWLEDGMENTS

The authors would like to express their gratitude and appreciation to all those who contributed to this study, either directly or indirectly.

REFERENCES

Al-Kalbani, A., Al-Harthy, F., & Al-Kindi, S. (2018). Traditional Omani architecture: Cultural identity and heritage conservation. *Journal of Middle Eastern Architecture, 12*(3), 45–60.

Al-Ghafri, A. S. (2018). Overview of the Aflaj of Oman. *ResearchGate.* https://www.researchgate.net/publication/328560516_Overview_about_the_Aflaj_of_Oman

Al-Riyami, S. (2020). The role of interior design in preserving Omani architectural heritage. *In* Proceedings of the International Conference on Architecture and Urbanism *(Vol. 8, No. 2, pp. 123-130).* [Publisher Name].

Al-Salmi, A., Gaube, H., & Lorenz, K. (2008). *Islamic art of Oman.* Mazon Printing, Publishing & Advertising.

Arabic Language Academy. (1960). *Al-Waseet dictionary.* Arabic Language Academy.

David, I. (2020, February 21). A look at the old gates of Oman. *Culture Trip.* https://theculturetrip.com/middle-east/oman/articles/a-look-at-the-ancient-doors-of-oman

DeFranzo, S. E. (2011). What is the difference between qualitative and quantitative research? *Snap Surveys.* https://www.snapsurveys.com/blog/qualitative-vs-quantitative-research/

Hejles, M. (2019). *Al-Mawrid Al-Waseet: A concise Arabic-English dictionary.* Dar El-Ilm LilMalayin.

Hegazy, S. M. (2014). Conservation of Omani archaeological sites, Harat Al-Bilad - A case study. *International Journal of Art and Sciences, 7*(4), 435-448.

Majid Al Muzayin, M. (1996). *Al-Mawrid Al-Waseet concise dictionary.* Dar El-Ilm LilMalayin.

Mujahid, A. (2018). *Temperature and salinity profiling analysis off Sarawak waters* (Master's thesis, Universiti Malaysia Sarawak). UNIMAS Institutional Repository.

Niche. (n.d.). *In ALDictionary.* https://www.aldictionary.com/definition/english-to-arabic/niche.html

Obidat, M. (2000). Research methodologies: Qualitative, quantitative, and mixed research methods in social sciences. *International Journal of Academic Multidisciplinary Research, 4*(6), 83–91. https://www.researchgate.net/publication/342588454_RESEARCH_METHODOLOGIES_QUALITATIVE_QUANTITATIVE_AND_MIXED_RESEARCH_METHODS_IN_SOCIAL_SCIENCES

Qudamaa, A. (2017). *Queen Sheba of Abyssinia is not Sabaean from Yemen.* https://tariganter.wordpress.com/2018/05/26/queen-sheba-of-abyssinia-is-not-sabaean-from-yemen/

Sheikh, R. (2019). It is considered one of the oldest residential communities in Oman. https://www.atheer.om/archives/491996

Zakaria, T. (2017). نافورَة الأقواس واجهَة جماليّة في مسقط . [Fountain arches façade aesthetic in Muscat]. https://www.omaninfo.om/images/library/file/Book768969.pdf