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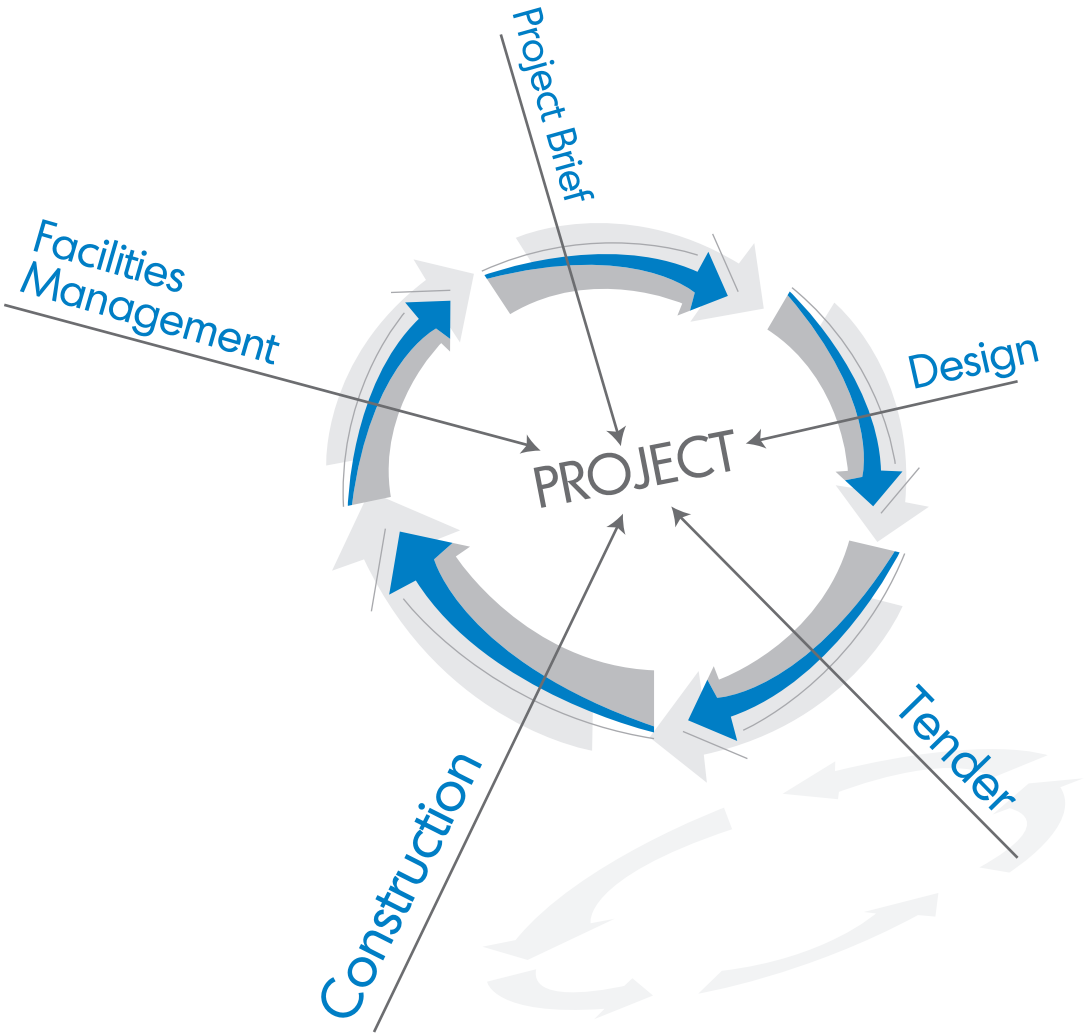

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Contents

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Secretariat

Editorial

Welcome from the Editors

Welcome to the thirty-sixth (36th) issue of Malaysian Construction Research Journal (MCRJ). In this issue, we are pleased to include nine papers that cover a wide range of research areas in construction industry. The editorial team would like to express our sincere gratitude to all contributing authors and reviewers for their contributions, continuous support and comments.

In this issue:

Rostam Yaman et al., investigated the total energy electricity usage based on different types of shopping mall design layout while understanding the awareness of end-user toward building characterised pertinent to energy uses of shopping malls. Field study was conducted by using two-low rise shopping mall in Klang Valley. The findings shows that open space building will contribute to low energy usage while the enclosed building contributes to higher energy demand. In conclusion, the total energy consumption in the building is affect by the building configuration and characteristics.

Zureen Norhaizatul Che Hassan et al., estimated the return period and level of extreme rainfall in Kuala Lumpur. The observation method by using Generalized Extreme Value (GEV) for more than 30 years was used. The findings show that three zones most vulnerable to flash flood caused by extreme rainfall identified are City Center, Damansara Penchala and Wangsa Maju-Maluri. It is suggested that three focused current solution are adaptation, vulnerability and resilience to disasters. The study also required the integration of disaster risk and risk management approaches with comprehensive development design as well as considering several aspects such as social, cultural, ethical, political, economic and legal.

Shamsida Saidan Khaderi and Yusnita Yub revealed the potential problems faced by the developers that resist green procurement implementation in the construction industry. Mixed methodology by using survey and semi-structured interview were used as data collection in this study. The findings show most of the respondents feels that the perception that green product would be more expensive as the main challenges, followed by lack of incentive for companies to implement green procurement. It is recommended that the developer have one decision that create a financial equilibrium in the long term to strike an economic, social, and environmental balance towards sustainable construction.

Ahmad Shazrin Mohamed Azmi et al., explored the governing structure challenges for the development of waqf land in Malaysia. Three groups of challenges has been identifies as legislation, administrations and obligations. Qualitative method through interview with fourteen (14) State Islamic Religious Councils (SIRCs) was done. The findings show that the legislation challenges would be perceived as the most rigid and difficult for the SIRCs to mitigate. The administration challenges are possible to be handled by the SIRCs if they can have strategies and possess the enabler to change certain administrative aspects. Meanwhile, the obligation challenges are depending on how the SIRCs able to understand and interpret the obligatory requirements sets by both the shariah and civil laws.

Anis Sazira et al., assessed the barriers for knowledge sharing practices by using cross-case analysis of joint venture projects as case studies. The methodology used in this study is qualitative approach using case studies towards selected construction joint venture in Malaysia. 20 interviewee by using semi-structured interview was done and the analysis conducted are content analysis and cognitive mapping techniques. Five (5) main barriers for knowledge sharing practices were identified which are cultural barriers, lack of loyalty and project continuity, language barriers, unwilling to share and learn; and lack of time.

Wahida Wahi et al., determined the level of Safety Management Practices (SMP) and identified the most critical dimensions of SMP among contractors operating in Sarawak, Malaysia by using a descriptive research design and a quantitative research approach. A simple random sampling technique is adopted to obtain data from Grade 6 contracting firms registered with CIDB in Sarawak, Malaysia. The findings showed that the SMP level among the contractors operating in Sarawak high and the relative importance index (RII) revealed that the most critical dimensions of SMP were management commitment to safety and the provision of personal protective equipment.

Fatin Aziz et al., identified the challenges faced by young adults in owning a house in Klang Valley. Quantitative method by using survey questionnaire with 385 respondents who stays and work in Klang Valley was used by using simple random sampling. Three (3) main factors identified as location, behavioral and financial as the main findings. Most of the respondents agree that housing located near workplace is highest importance in Location factor, while for Behavioral factor, Financial Literacy is the most important factor. Financial & Economic factor has identified that Risk / Fear of bad decision is the main factor in owning a house in Klang Valley.

Muhamad Saiful Alizan Nordin et al., analysed the risk and return of Malaysian REITs (M-REITs) and ALL-REIT portfolios during the COVID-19 pandemic. 24 Observations method was used for six (6) months before and 18 months after COVID-19 hits Malaysia. CAPM method suggested that M-REITs show a low deviation of performance with market portfolio during the pandemic, thus signifying that it is a low-risk investment and shall be included in any investment portfolios.

Nurul Asra Abd Rahman et al., carried out the analysis on the Building Energy Simulations (BESs) towards usefulness of BESs. Preferred Reporting Items for Systematics reviews and Meta-Analyses (PRISMA) was used in minimising bias and maximising contribution to the knowledge and increasing the citability of the article. The findings suggest that most tools are capable for energy-saving and cost-savingwhile some are capable to simulate energy audit, GHG emission and lighting quality.

Editorial Committee

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ENERGY CONSUMPTION IN OPEN AND ENCLOSED LAYOUT OF SHOPPING MALLS IN MALAYSIA

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Abstract
Shopping mall requires a huge amount of energy, in terms of embodied and operational energy needed to operate. This research aim is to investigate the total energy electricity usage based on different types of shopping mall design layout while understanding the awareness of end user toward the building characterizes pertinent to energy uses of shopping malls. This research was conducted at two low-rise shopping malls of AEON AU2 and AEON Alpha Angle in Klang Valley. The field study was conducted to explore the building configuration including the size, building form, orientation and opening. The data were collected and analyzed in order to have better understanding of total energy usage in these case studies. The Building Energy Index (BEI) in the case studies was calculated and the results are be compared. The results of study find that the BEI for open building has lower value than enclosed building.

INTRODUCTION

Today, commonly raised issues are major problems due to climate change that impact of energy demand is still on an upward trend caused by uncontrolled growth of development. Typically, an architect should design sustainable buildings and construction to reduce energy consumption in buildings as well as to improve the energy efficiency in the building. Besides, the increasing energy demand will lead to greenhouse gas emissions and environmental pollution which a need solution from the architect, developers, scientists, engineers and also the end user of the building to improve the quality of the building. While in the old day before the evolution of technologies, people rather use natural daylighting and natural ventilation as a comfort purpose by designing the large opening for air circulation and lighting.

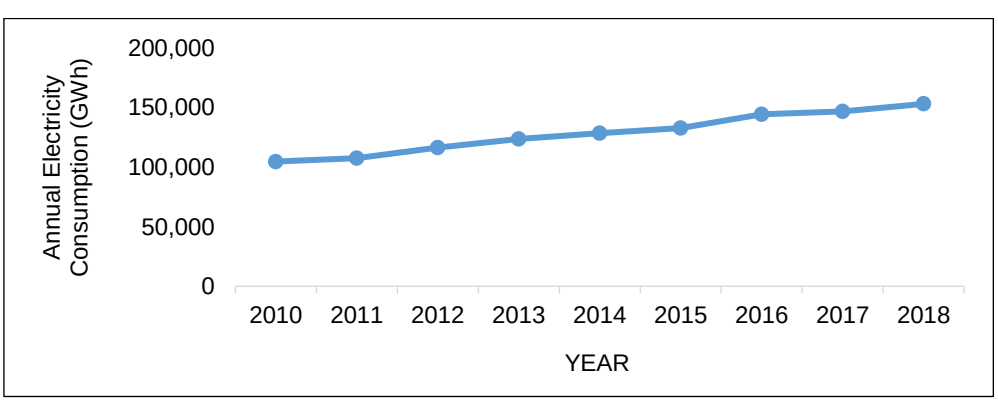


Figure 1. Annual Electricity Uses in Malaysia (2010-2018)

In Malaysia, the major concern on energy consumption is growing and its implications for both effect on the environment and ecosystems. Suruhanjaya Tenaga (Energy Commission) reported a 68% increase in the final electricity consumption in Malaysia during

the 8 years from 2010 to 2018. Figure 1 shows the electricity consumption from 2010 to 2018 by sectors. During these 8 years, electricity consumption rose from 104,589 GWh to 152,958 GWh. The greatest increase was between 2015 and 2016 with an increase of 8.7% from the previous year. The electricity use continued to grow at a slower pace. The total consumption of the five major electricity end uses, namely the agriculture, commercial, transport, industrial, and residential in Malaysia.

In the hot and humid climate of Malaysia, most of the electricity is used to create a thermally comfort-built environment through air conditioning. Therefore, various solutions have been taken to create awareness about saving energy in the building. Many architects have taken steps to build the quality building, which includes minimum pollution, cost-saving, increasing health, provide comfort, and also the safety of the building occupants. Hence, some green and energy efficient building strategies have been introduced in Malaysia that aims to reduce energy consumption as well as decrease global warming.

Thus, the aim of this of this research is to investigate the total energy usage based on different types of shopping mall design layout while understanding the awareness of end user towards the building characterizes pertinent to energy usage of commercial development such as shopping malls.

LITERATURE REVIEW

Design Strategies of the Buildings

An architect and designer overcome these issues with a passive design method as a suitable building. The building design with optimizing the natural daylighting and ventilation as the purpose of low energy building design. According to studies conducted by Azizi Bahauddin (2009), the first design strategy is should be the building site orientation on the north-south while preventing the east-west sun path and also the creativity of the architects in the proposed building design to introduce daylight into the deep space of buildings. But he further stated that weather conditions in Malaysia are constantly changing caused a totally dependence on daylight alone may not be advisable. In those cases, the electricity on illumination was increased and air-conditioning used raised was used to counter the indoor temperature. In present condition is not wise because such condition can be avoided by design layout (Bahauddin & et al., 2009); (Omrany, 2015).

Thus, the types of building layout one of the ways to increase energy efficiency. The open layout is the openings in the enclosing planes of a spatial field. (Ching, 2007); (Edwin Rodriguez-Ubinas, 2014) stated that an open layout is an opening at the walls that allow light to penetrate the space and illuminate the surface of a room, offers views from the room to the exterior establishes visual relationships between the room and adjacent spaces and provides for the natural ventilation of the space. According to (Ching, 2007), (Edwin Rodriguez-Ubinas, 2014). The light that enters a space through a corner opening washes the surface of the plane adjacent and perpendicular to the opening and this illuminated surface itself becomes a source of light and enhances the brightness of the space. The level of illumination can be enhanced further by turning the corner with the opening or adding a skylight above the opening. In relation to energy efficiency, the building layout can be designed according to building requirements and building functions.

Besides, the designers and architects should consider Building Energy Performance (BEP) while designing space layouts. In Malaysia, a hot humid climate is the main factor in designing shopping mall layout. Mostly, the shopping mall layout is enclosed types to provide comfort for occupants in uses of air-conditioning. The weather in Malaysia is not too hot and the daily temperature average between 21°C and 32°C. Typically, the Malaysian climate is influenced by the winds blowing from the Indian Ocean (Southwest Monsoon from May to September) and the South China Sea (North-Eastern Monsoon from November to March). Its annual rainfall is 80 percent a year which is between 2000mm to 2500mm (Malaysia Information, 2020). Therefore, this study is to investigate the characteristic of the building layout that affect energy use in the building.

Green Building

Since 2009, Malaysia's construction sectors have been introduced to Green Building Index (GBI) as an initiative to support the solution for global warming. According to Green Building Index Sdn Bhd, The Green Building Index (GBI) is Malaysia's industry recognized green rating tool for buildings to promote sustainability in the built environment and raise awareness among Developers, Architects, Engineers, Planners, Designers, Contractors and the Public about environmental issues and our responsibility to the future generations (GreenBuildingIndex Sdn bhd, 2020). The GBI rating tool provides an opportunity for developers and building owners to design and construct green, sustainable buildings that can provide energy savings, water savings, a healthier indoor environment, better connectivity to public transport and the adoption of recycling and greenery for their projects and reduce our impact on the environment (GreenBuildingIndex Sdn bhd, 2020).

Building Energy Index

Green buildings often fail to achieve optimum energy efficiency performance. When calculated, the actual energy consumption is different from that predicted at the design stage (Mokhtar Azizi, Wilkinson, & Fassman, 2015). Low energy design buildings represent both a load-reduction strategy and the incorporation of renewable energy resources and these buildings combine energy conservation strategies, such as renewable energy and energy-efficient technologies, the strategies often considered to be the cornerstone of sustainable design (Abdul Rahman, 2005). Abdul Rahman also stated that sustainable building is an integrated approach that minimizes the environmental impacts of building through its materials and design, construction techniques, and buildings operations and maintenance.

According to a study conducted by Fairuz & Byrd, 2012 on the Low Energy Office (LEO) Building located in Putrajaya is one of the building with energy efficiency and low environmental impact and design support from Danish Agency for Development Assistance (DANISA) aim to integrate the best energy efficiency measures that are optimized the best overall cost/effective solution. In their study, the method used to predict the energy savings and planned subsequent energy monitoring program by using the computer program called Energy 10. As the result, the Building Energy Index (BEI) for this building was stated as 114 kWh/m2 per year and it had decreased to 104 kWh/m2 per year. This building was design by following the code of Malaysian Standards (MS) 1525: 2001, "Code of practice on energy efficiency and use of renewable energy for non-residential buildings". In resulting follow this standard, this building was assumed to have an energy consumption of less than 135 kWh/m2

per year. However, the result shows that the actual energy consumption of this building is less than the standard and the expectation which means a lot better than the typical performance of new office buildings in Malaysia and the Asian region which usually have energy indexes of 200-300 kWh/m2 per year.

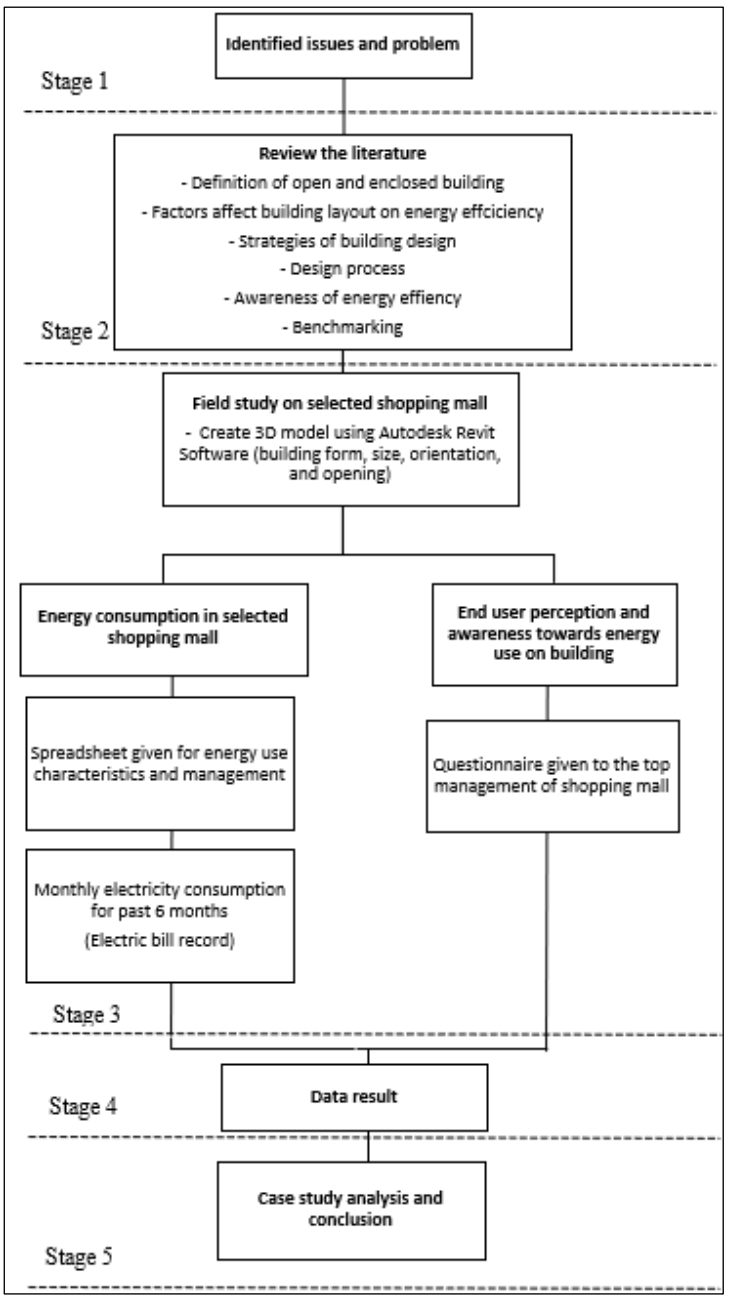
According to their study Fairuz & Byrd, the LEO Building was designed with some energy efficiency strategies include; creation of green landscaped areas around and on top of the building, optimizing the orientation with north and south-facing windows, the design of energy-efficient space planning, well-insulated building façade and roof, the windows are shading from direct sunshine and a 'double roof'. The main energy-efficient features include adopting a variable air volume (VAV) system which is energy efficient compared to a typical air-conditioning system (Mokhtar Azizi, Wilkinson, & Fassman, 2015). A spray mist system that emits water particles is installed at the sliding doors to cool natural ventilation (Mokhtar Azizi, Wilkinson, & Fassman, 2015).

Then, this building also used the energy-efficient cooling systems by using strategies the air volume for each zone is controlled individually according to demand and controlled individually according to daylight availability and occupancy to minimize the use of daylight and use of high-efficiency lighting (Sharifah & Hugh, 2012). The atrium is naturally ventilated and has large access to natural daylight through skylights (Mokhtar Azizi, Wilkinson, & Fassman, 2015). This building includes the energy-efficient office equipment and implementation of the Energy Management System (EMS) where performances of the climatic systems are continually optimized to meet optimal comfort criteria at least energy costs. Solar photo-voltaic are installed at the rooftop of the building to provide renewable energy for a water wall feature in the atrium (Mokhtar Azizi, Wilkinson, & Fassman, 2015). By integrating all strategies, this building proves that the types of design layout and building envelope acts as passive design that contributes to energy saving.

RESEARCH METHODOLOGY

This research was conducted on selected case study of two shopping mall that was located in Kuala Lumpur by focusing on the aspect of design enclosure and electricity uses. These two chosen shopping malls are within same location in order to have the same weather conditions. In this study, the chosen shopping mall are within the same property, typology and ownership. The chosen case study cannot be disclosed due to privacy agreement with researcher, thus in this study it will be nominated as Shopping Mall A (Open Layout) and Shopping Mall B (Enclosed Layout). This retail company was chosen because it has many branches in Malaysia with a variety of building designs.

The respondent was selected in team management of the shopping center. The purpose was to verify the understanding of end user based on their awareness and experiences in the environment of the buildings. The findings result of energy use in the shopping mall will be comparing and evaluate for energy saving. This research only focused on shopping mall design layout characteristics and the total energy uses pertinent to shopping malls. At the same time, this retail company can identify the way to saving energy in their building as well as keep their customer comfort.



Source: (Author, 2021)

Figure 2. Research Stages Flow Chart

Data Collection Method

The method was conducted via structured interviews to collect monthly electricity consumption and the major characteristic of electricity end used. The spreadsheet was designed for the management property to collect the data of energy use monthly.

On-site Visit and Observation Method

The site visit and observation method were conducted to identify the case study shopping mall that illustrates the similarities and differences characteristics by focusing on total gross floor area (m^2), size of opening, shading and air conditioning.

Data Analysis and Finding

The data that collectively form the management property on energy use information will be comparing and analyze carefully to find the differential between the two-case study. The data collection on-sites visit and observation will be record based on similarities and different characteristics. Lastly, the analyses of the questionnaire of the total electricity.

ANALYSIS AND DISCUSSION

User Perception

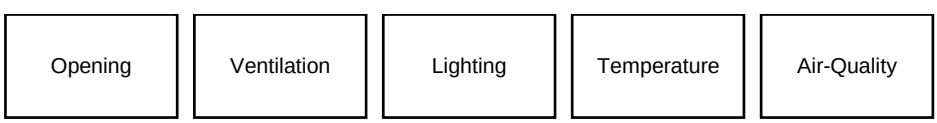


Figure 3. Characteristics of Building Pertinent to Energy Saving

Based on the data analyses of the questionnaire, most of the end users aware of the opening wall in the buildings. Most of the respondents agreed that the AU2 was a type of open space building mall. In addition, the building type is the only design with the open space concept for AEON Mall that is in contrast with other common design of AEON Malls. Meanwhile, the respondents at Alpha Angle also aware that there was no opening wall in the building except for the entrance. This a resulting from the use of the fully air conditioning system in the building. However, most of the respondents agreed that the building with the opening in walls design will contribute to energy saving. Mostly all of the respondents understand the natural ventilation will distribute through the building opening to support building ventilation. However, there were several respondents that less comfortable with the ventilation in the building due to the less ventilation distribute into the building on a certain time yet the additional ceiling fan will support the ventilation. Furthermore, all of the respondents aware that the natural ventilation in the building will reduce the electrical energy usage for the building to operate. Natural ventilation acts as the passive design that contributes to the energy efficiency of the building. In addition, most of the respondents at Alpha Angle are aware the building using fully air conditioning system that will contribute to energy demand in the building.

Based on data analysis, all of the respondents are aware there were natural lighting that contributes to the building AU2. They also agreed that the source of daylight through the opening and roofing skylight contribute to reducing electricity usage for artificial lighting. Meanwhile, all of the respondents at Alpha Angle were aware there was no natural lighting distribute in the building space due to lack of building opening wall. Therefore, the building is using totally artificial lighting to support the illuminance. As a result, all of the respondents from both case studies are aware the natural lighting will contribute to reduce the electrical energy usage in the mall. The maximum use source of sunlight during day time will reduce

the usage of artificial lighting in building as well as reduce the cost. Based on the data analyses, most of the respondents are satisfied with the air quality in both case studies. The type of building with the open and enclosed buildings has a similar effect on the level of satisfaction of user comfort on the air quality.

Next, the temperature in the building is based on user satisfaction level. According to data analysis, all of the respondents from Alpha Angle are satisfied with the temperature surrounding the building. This is resulting of the full air conditioning system used for the cooling effect in the building. This gives a comfortable effect in the respondent environment. Meanwhile, in AU2 mostly of the respondents are feeling normal on the temperature environment. However, the respondents do not feel hot or not comfortable in the building. Thus, the characteristics of the building will affect the perception of the user yet the user also aware that the passive design of the building itself is very important in reducing the total energy demand in the building. In conclusion, the objectives of this dissertation are being achieved based on the result and findings from the questionnaire conducted in both case studies.

Building Utilization

Case Study 1: Shopping Mall A is the only mall within this corporation designed with the concept of open space in the Klang Valley area. Generally, the main supermarket and department store using a fully air conditioner system while the others tenant at the open space area which there is also an air conditioner system and fan provided in this area. The air conditioner system at the open space area is not used at all because this area has adequate natural ventilation that contributes to thermal comfort at this area. Case Study 2: Shopping Mall B is the earliest malls within this corporation built in Klang Valley area and never made any renovations. Case Study 2 is a fully enclosed building and only have the entrance opening. Thereby, Case Study 2 using a fully air conditioner system and artificial lamps in all areas. These two case studies consist of a category of supermarkets, department stores and other tenants.

Building Operation

Table 1. Building Operation Hours at Selected Case Study

Operation Hours	Malls	
	Shopping Mall A (Open Space)	**Shopping Mall B (Enclosed)**
Building Operation per Day	12 hours	12 hours
Building Operation per Week	84 hours	84 hours
Air-Conditioning System per Day	None	12 hours
Artificial Lighting System	9 hours	12 hours

Table 1 above shows the information of building operation at selected case study include the information of building operation per day, building operation per week, air-conditioning system per day, artificial lighting system per day. As stated above, building operation per day and per week similar between these two-case study areas which is the building operates 12 hours per day and 84 hours per week. However, the operation hour is not including the overall operation time throughout the year due to the force of Movement Control Order (MCO)

whereby during March until May the building operation hours are from 8 a.m. to 8 p.m. while the normal operation hour is from 10 a.m. to 10 p.m.

This is followed by the information on the air conditioning system per day. The fact that Shopping Mall A does not utilize the air conditioner system in the open space area. However, the building yet supplies and provide the air conditioner at all area include providing the ceiling fan. In place of air conditioning system operation hours at Shopping Mall B is 12 hours per day which signifies that the building is fully air conditioning at all time along the day. The information of operation hours for artificial lighting system for Shopping Mall A is 9 hours whereby the system will be utilized when the weather begins to be overcast. The fact that the average system hours per day is 9 hours from 1 p.m. until close 10 p.m. Moreover, the operation hours for the artificial lighting system for Shopping Mall B is 12 hours which means the building utilizes the system all the time from 10 a.m. to 10 p.m. The fact that there is dissimilar of operation system hour for air conditioning and the artificial lighting system between these two case studies whereby Shopping Mall B longer operating hours compared to Shopping Mall A.

Building Energy Index

Electricity Energy Usage

Table 2. Data of Electricity Energy Usage at AEON AU2

Shopping Mall A													
Month	**Jan**	**Feb**	**Mac**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
E.U (kWh)	70122	71112	65980	66450	66871	71433	72890	68196	69310	70655	69487	71488	883,994

Table 2. Data of Electricity Energy Usage at AEON Alpha Angle

Shopping Mall B													
Month	**Jan**	**Feb**	**Mac**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
E.U (kWh)	89011	88521	77398	74062	70198	89700	87448	92521	91392	89632	87667	92501	1,030,051

Table 1 and Table 2 above show the electricity energy usage by monthly at Shopping Mall A and Shopping Mall B. The data of electrical usage are collected from the Building Manager of the Shopping Mall A and Shopping Mall B based on a meter reading at TNB room that has been recorded monthly. The average monthly of electricity used for Shopping Mall A is 73,666 kWh per year less than Shopping Mall B which is 85,837 kWh per year. The electricity usage is based on the breakdown of the electricity usage which is the operation hours of the building, the number of the lifts and the escalators, the use of air conditioning system (HVAC) and the lighting system. This can be concluded that Case Study 2 which is Shopping Mall B using more electrical sources than Case Study 1 which is Shopping Mall A.

Calculation of BEI

Building Energy Index is calculated based on the total electricity usage per year and divided by the total gross floor area. In Malaysia, the BEI for Green Building Index for the retail building is 240 kWh/m²/year for low-end outlets and 350 kWh/m²/year for high-end outlets. Thus, the two case studies are considered as low-end outlets which is the design of

conventional method and the envelope of common materials. The calculation detail for each case study stated as below.

Calculation of Building Energy Index: Case Study 1 Shopping Mall A

Total Energy usage = 833,994 kWh
Total Gross Floor Area = 3,364.8 m²
AU2 BEI = Total Energy usage / Total Gross Floor Area
= 833,994 kWh / 3,364.8 m²
= 248 kWh/m²/year

Calculation of Building Energy Index: Case Study 2 Shopping Mall B

Total Energy usage = 1,030,051 kWh
Total Gross Floor Area = 3,489 m²
AU2 BEI = Total Energy usage / Total Gross Floor Area
= 1,030,051 kWh / 3,489 m²
= 295 kWh/m²/year

As for discussions, from the calculation it can be analyzed that the BEI for Case Study 1 Shopping Mall A is 248 kWh/m²/year less than in comparison with BEI for Case Study 2 Shopping Mall B which is 295 kWh/m²/year. In relation to benchmarking of GBI for retail building show that both of the case studies building is higher than the benchmark. However, we can observe from the result there slightly differing result of BEI of the case studies which is. The possibility that can conclude the design of open space building Shopping Malls is less BEI compared to enclosed building Shopping Malls.

CONCLUSION

In conclusion, the total energy consumption in the building is affect by the building configuration and characteristics. Therefore, the aim of this research is to investigate the total energy consumption in two different types of building enclosure which is Case Study 1 open type while Case Study 2 is enclosed type building. In resulting that open space building will contribute to low energy usage while the enclosed building contributes to higher energy demand. This has been proved by the value of BEI on Case Study 1 which is open design is lower than the value of BEI on Case Study 2. This result is based on the factor of the building design characteristics. Typically, the design of shopping malls in Malaysia is enclosure type that causing energy demand.

The open space building with passive design characteristic includes building orientation, building form, windows opening, daylight, as well as the design of the building itself that take advantage of maximizing the natural ventilation and natural lighting opportunities in low energy building. The overall study finds that the users are aware of the factors of building characteristics they can contribute to energy saving. Therefore, the upcoming retail building

should be built with open concept building while take considers to other factors. Disclosure of benefits on this matter should be highlighted to the team involved in creating efficiency building.

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MAPPING SPATIAL URBAN RAINFALL EXTREMES UNDER VARIOUS RETURN PERIODS IN KUALA LUMPUR FOR SUSTAINABLE URBANIZATION

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Abstract

Kuala Lumpur is a city characterized by a warm and humid climate throughout the year. Extreme rainfall occurrences and catastrophic floods in the city often have an impact on social, economic, and environmental structures. Rapid development and increase in population density caused the city more vulnerable to harmful consequences. The objective of this study is to estimate the return period and level of extreme rainfall in Kuala Lumpur. In this work, observed extreme rainfall of Kuala Lumpur was investigated over more than 30 years. The data were statistically analyzed using Generalized Extreme Value (GEV). Extreme rainfall assessment is viewed from the perspective of spatial analysis. Return periods of 20, 50, and 100 years of extreme rainfall showed an increasing trend. Four different rainfall aggregation periods considered in this study are 1, 3, 12, and 24 hours. At intervals of 20, 50, and 100 years, the spatial extreme rainfall distribution in Kuala Lumpur showed similar distributions for 1 hour to 24 hours. The three zones most vulnerable to flash floods caused by extreme rainfall identified: City Center, Damansara-Penchala, and Wangsa Maju-Maluri. Extreme rainfall analysis is crucial as it depicted the extreme rainfall behaviour in Kuala Lumpur for design planning purposes in sustainable urbanization and therefore devising strategies for future projected disaster risk.

Keywords: *Extreme value theory, Generalized Extreme Value, extreme rainfall, design rainfall.*

INTRODUCTION

Development is often the benchmark of a country's progress. The vibrant urbanization process in the cities of the country seems endless. The growth in population led to increased use of land to accommodate population and demand. The development is to ensure the construction of industrial areas, commercial hubs, residential areas, and road construction indirectly contribute to the physical changes. Hence, the physical changes of the environment caused implications for urban development, which contributes to the factors of environmental disasters (Anuar & Azlan Shah, 2016). The rapid urbanization process in Kuala Lumpur has also made the phenomenon of flash floods a serious environmental issue arising from the physical changes of the environment.

The flash flood phenomenon in Kuala Lumpur is closely linked to rapid development and has seen the reduction of green areas and forests as well as the replacement of natural surfaces with roofs and concretes that have restricted water absorption rates. Flash floods are already synonymous with Kuala Lumpur that due to various factors.. The major factor is urbanization and the second factor is natural factor comprising lithology, terrain, heavy rainfall, and river drainage system (Angel et al., 2018) and (Norashikin et al., 2018).

Urbanization influenced climate and hydrological cycles with soil closures and surface albedo, thereby additional heat released to the atmosphere and air pollutants emitted which caused the interactions with clouds and radiation (Marshall, 2005) and (Shouraseni & Fei, 2009). Research studies highlighted that high aerosol disruption leads to evaporation, which alters the rainfall locally and hence, the organization of stratocumulus clouds can be changed (Feingold et al., 2010) (Hailong & Graham, 2009). The presence of aerosols in convective clouds complicates the natural interactions of dynamic, thermodynamic, and microphysical processes. Thus, an imbalance in the energy cycle in the climate system leads to an increase in temperature and intensity of rain. The interaction of environmental components is known as dynamic and constantly changing with space and time.

The increased incidence of flash floods and landslides are due to increased rainfall intensity (Siti Jahara et al., 2021) and (Syafrina et al., 2015). Extreme rainfall phenomena are discussed globally due to its major caused of human losses associated with natural disasters as well as large-scale socioeconomic losses, especially in urban areas. Extreme rainfall has intensified since 1981 in urban areas of Kuala Lumpur compared to in its surrounding rural areas (Yafei et al., 2020). Some researchers predicted the increased precipitation and extreme rainfall worldwide (Niyogi et al., 2017) (Oliveira & Lima, 2019) (Zou & Ren, 2015). Thus, the rapid growth of the population created problems in sustainable development while maximizing the potential for destruction due to extreme rainfall.

The measurement of the rainfall return period is closely related to extreme rainfall and flash flood. Evaluation of the rainfall return period is very important in predicting the likelihood of extreme rainfall in the future. The frequency analysis is one of the most significant statistical approaches for predicting the likelihood of future extreme events with the reference of previous data (Nur Khaliesah et al., 2019). The extreme rainfall analysis has not received much coverage other than visual or graphical interpretation, in which difficult for decision-makers to resolve rainfall issues. The analysis should be conducted to minimize the effects of extreme rainfall in Kuala Lumpur. Extreme rain knowledge, as well as the use of statistics, are indispensable in sustaining the urban management and planning.

In this regard, this research studied on the issues highlighted for depth understanding because of its significant impact on the social, economic, and infrastructural aspects of the city. This study will pave the way of state-of-the-art research area on this extreme rainfall for return period and its level particularly in Kuala Lumpur. The objective of this study is to estimate the duration and extent of extreme rainfall in Kuala Lumpur.

METHODOLOGY

Study Area

Kuala Lumpur is the heartbeat of the Malaysian capital and is the most advanced and compact city in Malaysia. Kuala Lumpur is located in Peninsular Malaysia in the middle of the state of Selangor located at 3° 8 'North and 101° 41' East. Kuala Lumpur is the capital and largest city in Malaysia with an area of 244 square kilometres. It is located within Klang Valley that borders the Titiwangsa Range to the east, some of the lowlands to the north and south and the Straits of Malacca to the west. Klang and Gombak rivers run through the centre of this metropolitan city. The Klang River Basin is Malaysia's fastest growing drainage basin.

A valley denominated after the Klang River called Klang Valley embodies the unique features of the city (Tariqur Rahman et al., 2018). The rainfall is abundant during the inter monsoonal period around March to April and September to October and it is additionally kenned that convective rainfall frequently occurs on the West Coast of Peninsular Malaysia. (MMD, 2009).

The city of Kuala Lumpur was chosen as the study location because it serves as the country's economic and social hub. Kuala Lumpur's rapid development has a complex impact on the city's physical environment. The main goal of this study is to investigate the relationship between the phenomenon of extreme rainfall and flooding, as well as to evaluate the development design perspective using extreme rainfall analysis.

Data Sets

This study is based on the rainfall data based on hours and the data obtained for the period of 30 to 42 years, from 1976 to 2017. Nine stations are selected as the study stations in this research. Record availability data varied by the station, in which certain stations recorded a high percentage of data loss. The missing data percentage was less than 15% and the data were considered missing in this study (Mardhiyyah et al., 2015). Only extreme values are considered in this study, so the extreme value data is considered to be available. The basic information of the data source and percentage of the data as shown in Figure 1 and Table 1.

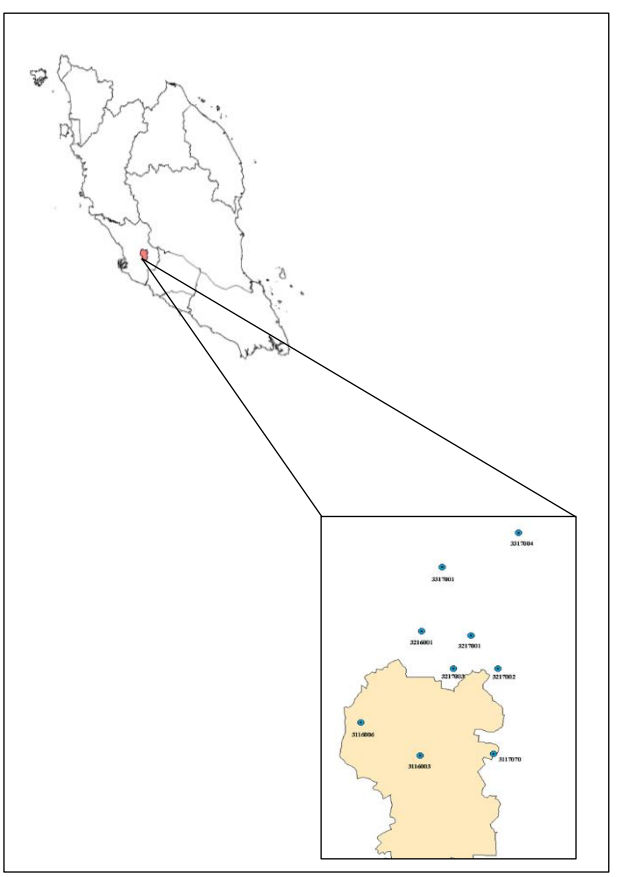

Figure 1. Study Location

Table 1. Station Information

Station ID	Station Name	Latitude (U)	Longitude (N)	Gaps (%)
3116003	Ibu Pejabat JPS	3° 09' 05"	101° 41' 05"	2.4
3116006	Ladang Edinburgh	3° 11' 00"	101° 38' 00"	2.4
3117070	Pusat Penyelidikan Ampang	3° 09' 11"	101° 44' 56"	2.4
3216001	Kg. Sg. Tua	3° 16' 20"	101° 41' 10"	11.9
3217001	Ibu Bekalan KM16	3° 16' 05"	101° 43' 45"	0
3217002	Empangan Genting Kelang	3° 14' 10"	101° 45' 10"	2.4
3217003	Ibu Bekalan KM11	3° 14' 10"	101° 42' 50"	0
3317001	Air Terjun Sg. Batu	3° 20' 05"	101° 42' 15"	0
3317004	Genting Sempah	3° 22' 05"	101° 46' 15"	14.3

Generalized Extreme Value (GEV)

Various methods are used through various distribution functions to identify the characteristics of rainfall distribution. The selection of the best probability distribution function using rainfall data is of interest to researchers in the field of hydrology. Most of the theory of probability applied in hydrology includes Normal Distribution, LogNormal, Pearson III, Log-Pearson III, Exponential, Gumbel, Generalized Extreme Value (GEV), Generalized Pareto Distribution (GPD), Generalized Logic and Power Law. Extreme Theory Value was first discovered by Fisher and Tippett (1928), and Gnedenko (1943) formulated the maximum block of distribution of Extreme Value (EV) with the incorporation of three single models, Gumbel, Frechet and Weibull introduced by Jenkinson (1955).

The continuous development of extreme rainfall is gaining attention in Malaysia and some researchers found that GEV is the most suitable source for analyzing extreme rainfall in Malaysia (Annazirin et al., 2013); (Noratiqah et al., 2013); (Syafrina et al., 2019). Accordingly, the GEV distribution is chosen in this study to analyze the extreme rainfall in the study area. The GEV distribution is then divided into three; namely Gumbel, Frechet and Weibull. This GEV distribution consists of three types of distributions:

Type I (EV1) extreme distribution for $\kappa = 0$, Type II (EV2) distribution for $\kappa < 0$ and Type III for $\kappa > 0$ (Martins & Stedinger, 2000). The analysis of extreme rainfall distributions is classified into annual Extremes (AE) and Partial Duration (PD) series (Wan Zawiah et al., 2009). The AE method involved the selection of the maximum annual rainfall value. GEV is widely used in extreme events such as floods, droughts, sea levels and storms (Syafrina et al., 2019). The probability density function and the cumulative distribution function for the GEV distribution are, as equations (1) and (2):

$$f(x) = \frac{1}{\alpha}\left(1 - \frac{\kappa}{\alpha}(\chi - \varepsilon)\right)^{\frac{1}{\kappa}-1} eksp\left(-\left[1 - \frac{\kappa}{\alpha}(\chi - \varepsilon)\right]^{\frac{1}{\kappa}}\right) \tag{1}$$

$$F(x) = \begin{cases} eksp\left(-\left(1 - \frac{\kappa}{\alpha}(\chi - \varepsilon)\right)^{\frac{1}{\kappa}}\right), & if\ \kappa \neq 0 \\ eksp\left(-eksp\left(-\frac{1}{\alpha}(\chi - \varepsilon)\right)\right), & if\ \kappa = 0 \end{cases} \tag{2}$$

The ε, α and κ parameters are referred to location, scale, and shape parameters, respectively. The value of the κ parameter affected the range of random variables χ. When

the value of κ is negative, the variable X is in the range $\varepsilon + \frac{\alpha}{\kappa} < \chi < \infty$, thus suitable for analysis of extreme conditions such as maximum rainfall. However, if the value of κ is positive, the variable X is within the range $-\infty < \chi < \varepsilon + \frac{\alpha}{\kappa}$, and has the upper limit here, thus its best suited to the study of extreme condition such as the minimum streamflow. If the parameter value is κ = 0, the GEV distribution is the Gumbel distribution and is also known as the Extreme Type 1 (EV1) distribution. The quantile function known as the cumulative distribution function of the GEV distribution is represented by:

$$Q(F) = \varepsilon + \frac{\alpha}{\kappa}\left(1 - (-\ln(F))^{\kappa}\right) \tag{3}$$

Extreme rainfall return values during the T-year, xt can be obtained when the estimates of parameter values of ε, α and κ are obtained. The rainfall period, xt is expressed as follows:

$$x_t = \varepsilon + \frac{\varepsilon}{\kappa}\left(1 - \left(-\ln\left(1 - \frac{1}{T}\right)\right)^{\kappa}\right) \tag{4}$$

Estimation of extreme rainfall over the 100-years period can be generated using GEV. The 100-years extreme events expected to occur with a probability of 1/100 at a return level are estimated. The estimation for the distribution parameters used in this study by using the L-moment method. The L-moment method is an appropriate parameter estimation method for estimating extreme parameters for small data samples (Richard M. & Neil M., 1993). Generally, the location parameter (ε) indicated the average of something or the position of the distribution. The positive ε parameter value indicated that the distribution position is shifted to the right whereas the negative ε value indicated that the distribution position shifts to the left. The scale parameter (α) in turn demonstrated the scattering size of the distribution. While, the shape parameter (κ) denoted as the shape or inclination of the angle of distribution whether it is inclined to the left or to the right. A large κ value will make a sloping distribution to the right and a small κ value will influence the sloping distribution to the left.

Goodness of Fit

Three goodness of fit tests were conducted in this study, namely, Kolmogorov-Smirnov Test (KS) test, Anderson Darling test (AD) and Chi-square test. The theoretical distribution is selected as the most appropriate model for extreme rainfall forecast in each data set, along with test statistics, by observing the significance values (p-values), as well as critical values for significant levels. The best distribution will be selected by identifying the p-value of the AD test that is greater than the significance level of 0.05 as well as the largest p-value of each distribution. The chi-square test is to be assessed at a significance level of 0.05. The lowest chi-square statistical value yielded a large p-value, and this proved the best fit. Comparison of statistics with KS, AD and Chi-square tests respectively for the goodness of fit showed that the most suitable distributions for each station are L-moment values (0.997,0.920 and0.648). All three tests suited at the 0.05 significance level proved GEV distribution is consistent with the extreme rainfall data set.

Kolmogorov-Smirnov Test (KS)

The KS test is performed by comparing the observed distribution and the frequency distribution obtained from the alternating process distribution of the update. This test is used to determine whether the sample is derived from the hypothetical continuous probability distribution function. The test is based on the largest vertical difference between the theoretical and empirical cumulative distribution functions. For random variables X and samples (x1, x2, ... xn) the empirical cumulative distribution function X (Fx (x)) is represented by equation (5):

$$F(x) = \frac{1}{n}\sum_{i=1}^{n} I(x_i \leq x) \tag{5}$$

that is, *I* (condition) = 1 if true and vice versa.

The two cumulative distribution functions F_x and F_y, the Kolmogorov-Smirnov test statistics (D_+ and D_-) are represented by:

$$D_+ = \max_x \left(F_x(x) - F_y(x)\right) \tag{6}$$

$$D_- = \max_x \left(F_y(x) - F_y(x)\right) \tag{7}$$

Anderson Darling Test (AD)

The Anderson Darling (AD) test presented by Anderson and Darling (1954) is one of the adaptive goodness tests used to select the non-parametric distributions in this study. According to Stephens (1976), the AD tailoring efficiency test provides a better fit than the Pearson chi-square test for small data samples. AD statistical tests can be represented as:

$$AD = -n - \frac{1}{n}\sum_{i=1}^{n}(2i-1)\left[\ln F(y_i) - \ln(1 - F(y_{n+1-i}))\right] \tag{8}$$

with i = 1,2, ..., n.

F(.) is the cumulative distribution function of a particular distribution, yi is the observation of -i and n is the number of observations. The best distribution will be selected by identifying the Anderson Darling test p-value greater than the significance level of 0.05 as well as the largest p-value for each distribution.

Chi-square Test (CS)

CS test is calculated based on the difference in the frequency of the observation distribution and the frequency produced by the distribution of the alternating process of the update. Pearson chi-square adaptability test is represented as the following equation:

$$X^2 = \sum_{i=1}^{nc}\frac{(O_i - E_i)^2}{E_i} \tag{9}$$

O_i = observation frequency,

E_i = the frequency produced by the distribution of the process of alternating updates for the extreme and nc = the number of cases.

This study set the CS test to be assessed to have a significance level of 0.05. The lowest chi-square statistical value yielded a large p-value, and this proved the best fit.

Spatial Interpolation Techniques

There are several modules in GIS applications to conduct interpolation analysis including Inverse Distance Weighted (IDW), Kringing, Spline and Topo to Raster (Fatih && Faruk, 2019). The IDW method is based on the assumption that the surface to be interpolated should be affected by the nearest point and at least by the farthest point. The IDW interpolation method is a good medium to foster understanding and analyze rainfall incidence (Muhammad Fikri & Nor Eliza, 2016). The IDW method is utilized in this study to visually examine the spatial correlation and extreme rainfall analysis.

Nine rainfall stations have been used to analyze the distribution rainfall depth pattern by using the IDW spatial interpolation technique in this study. The increment values of all the return periods of different extreme rainfall events are estimated and interpolated utilizing the IDW method to prepare a contour map to display the spatial variability in increment values.

RESULTS AND DISCUSSION

Determination of GEV for Extreme Rainfall

Extreme rainfall data according to the time interval is then matched to the GEV Distribution. The GEV is fitted to extreme rainfall time series obtained from the rain gauge stations. The parameters of the fitted distribution are estimated by the L-moments, as in Table 1.

Table 1. Parameter Estimation Using L-Moments

Hour	Parameter	Station ID								
		3116003	3116006	3117070	3216001	3217001	3217002	3217003	3317001	3317004
1	ε	67.7	65.9	67.9	53.6	60.6	60.1	62.5	64.4	58.6
	α	11.4	21.1	15.0	12.2	13.1	14.3	16.4	13.1	14.3
	κ	-0.03	-0.30	-0.21	-0.28	-0.11	-0.15	-0.25	-0.22	-0.20
3	ε	79.9	81.5	82.0	65.6	80.6	79.6	82.3	80.6	74.0
	α	14.9	25.0	18.9	14.1	15.2	17.4	18.7	15.2	13.4
	κ	0.00	-0.35	-0.15	0.00	-0.05	-0.24	-0.33	-0.05	0.03
12	ε	86.4	87.2	92.8	71.3	87.1	89.1	88.0	90.0	81.2
	α	17.1	26.0	21.6	15.1	16.2	21.5	18.0	18.0	15.0
	κ	0.00	-0.36	-0.30	0.00	-0.09	-0.35	-0.11	0.00	0.00
24	ε	97.2	97.8	103.0	93.4	98.8	96.7	99.6	100.3	93.7
	α	18.3	36.3	23.7	14.5	18.2	23.7	24.9	20.7	14.9
	κ	0.00	-0.17	-0.12	0.00	-0.11	-0.17	0.00	0.00	0.00

In general, the location parameter, ε indicated the average of the distribution. A positive parameter value ε demonstrated the position of the distribution shifts to the right and the negative value of ε showed the position of the distribution shifts to the left. The scale

parameter, α in turn indicated the size of the distribution. Whereas, the shape parameter, κ demonstrated the tendency of the skewness of distribution either sloping to the left or to the right. A large value of κ displayed a sloping distribution to the right and a small value of κ affected the sloping distribution to the left.

Goodness of Fit

Nine sets of extreme rainfall data matched the theoretical distribution of extreme values that best suited the KS goodness of fit test. The theoretical distribution selected as the most suitable model for extreme rainfall forecast in each data set, along with the observed significance values (p-values), and critical values for significant levels are expressed in Table 2.

Table 2. Goodness of Fit (GoF)

Hour	Parameter	Station ID								
		3116003	**3116006**	**3117070**	**3216001**	**3217001**	**3217002**	**3217003**	**3317001**	**3317004**
1	KS	0.947	0.312	0.477	0.438	0.771	0.665	0.632	0.65	0.354
	AD	0.147	0.412	0.871	0.711	0.327	0.87	0.698	0.753	0.601
	CS	0.050	< 0.0001	0.379	0.132	0.045	0.254	< 0.0001	0.124	< 0.0001
3	KS	0.833	0.529	0.404	0.987	0.605	0.319	0.196	0.154	0.916
	AD	0.003	0.190	0.439	0.754	0.01	0.333	0.555	0.590	0.548
	CS	0.099	< 0.0001	0.098	0.014	0.055	0.227	< 0.0001	0.0026	0.334
12	KS	0.886	0.506	0.235	0.984	0.682	0.211	0.811	0.715	0.785
	AD	0.017	0.198	0.591	0.826	0.009	0.778	0.433	0.005	0.786
	CS	0.648	< 0.0001	0.001	0.051	0.214	0.024	0.107	0.006	0.156
24	KS	0.742	0.234	0.178	0.568	0.81	0.363	0.737	0.786	0.254
	AD	0.004	0.002	0.007	0.525	0.39	0.432	0.058	0.011	0.214
	CS	0.110	< 0.0001	0.043	0.621	0.233	0.115	< 0.0001	0.275	0.128

The best distribution will be selected by identifying the p-value of the AD test to be greater than the significance level of 0.05 and the largest p-value of each distribution. This study set the CS test to be assessed at a significance level of 0.05. The lowest chi-square statistical value yielded a large p-value, and this proved the best of the best fit. Comparison of statistics with KS, AD and KKD tests respectively for the goodness of fit test showed that the most suitable distribution for each station is L-moment values (0.987, 0.871 and 0.621). All three test suitability tests at the 0.05 significance level proved that the GEV distribution was consistent with the extreme rainfall data set.

Estimation and Mapping of the Extreme Rainfall Return Period

The frequency of extreme rainfall often results in disasters and impacts on life. The extreme rainfall phenomenon in Kuala Lumpur has notable impacts on economic, social, and environmental. This phenomenon is difficult to predict and is comonly associated with high rainfall intensity, as extreme rainfall usually occurred over a short period.

In general, all stations showed an increasing trend for each recorded extreme rainfall period and recorded some peaks for the highest extreme rainfall. The increase in the trend of extreme rainfall is first detected around the 1980s and showed a steadily increased. The increase in extreme rainfall can trigger the phenomenon of flash floods around the city of

Kuala Lumpur, which in turn is also capable of causing landslides. Extreme rainfall is a major cause of natural disasters as it led to severe erosion, potentially increased soil loss and rapid sediment movement and lead to landslides and flash floods, and consequently posed a threat to life and property (Römkens et al., 2002) (Santiago & Sergio M., 2006).

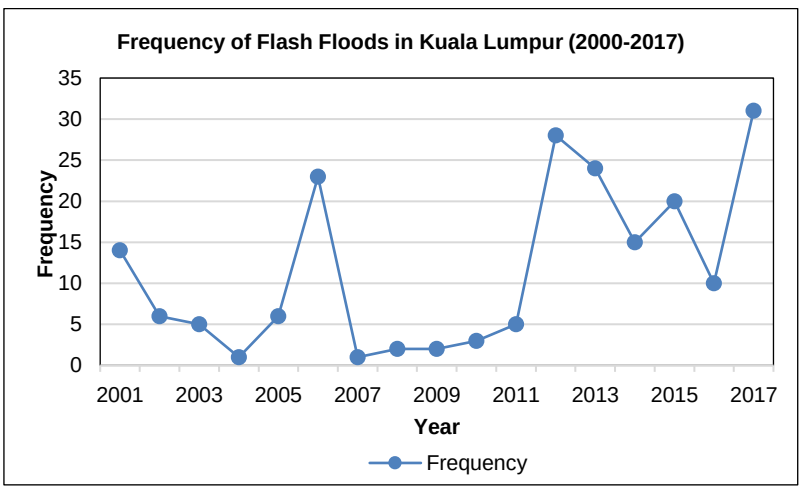

Figure 2. Frequency of Flash Floods in Kuala Lumpur (2000-2017)

Figure 2 shows the frequency and increase of flash floods that occurred in Kuala Lumpur for a period of 17 years from 2000 to 2017. A total of 201 cases of flash floods occurred in Kuala Lumpur during that period. Three maximum peaks were detected and 24 and 29 cases recorded respectively in 2005 and 2011. It can be observed that the third peak detected as the highest frequency recorded in 2017 with 31 cases of the flash floods that occurred in Kuala Lumpur. From 2006 to 2010, the number of flash flood events recorded was low with less than 5 cases, yet showed the increasing trend. The highest recorded rainfall of 113.4mm in 2013 for one hour. The frequency classification of flood areas has been carried out and it was found that the City Center of strategic zones as the most frequently experienced flash floods (Tariqur Rahman et al., 2018). The rapid development and population density was clearly influenced the frequency events of flash floods.

Flash floods occurred frequently during the inter monsoonal period in April and May, and October and November. The inter-monsoons were characterized by multifaceted wind patterns as well as unstable atmospheric conditions. Skies are usually clear and cloudy in the morning and this helps the formation of thunderstorms in the afternoon. Convection clouds and stratus clouds produced different rainfall intensities (Nordila et al., 2006). Convection clouds typically bring convection rains, which are dense in a short period of time. The intensity of rainfall depends on the processing of water vapour in the clouds. High-intensity rainfall has the tendency to occur over a short period of time in the tropics, while the low-intensity rainfall has a longer duration. Convection rain is divided into three types based on duration and intensity, namely rain episode less than six hours, and high intensity, medium, medium-term rain episodes (between 6 and 72 hours) and high intensity and long term episodes (about 1 week) with low increase intensity value. Types of rainfall (1) are widely detected in urban areas and caused flash floods (Barnolas & Llasat, 2007) (Nordila et al., 2006).

Return Levels of Extreme Rainfall for 20, 50 and 100 Years Return Period

The GEV distribution has proven to be appropriate in this study to determine the value of extreme rainfall estimation for the return periods of 20, 50 and 100 years. The return level obtained from the series of extreme rainfall return periods that formulated by selecting the highest value of extreme rainfall estimation, as shown in Table 3.

Table 3. Highest Value of Extreme Rainfall Estimation

P = 1/T	Return periods T-years, x	1 hour (mm)	3 hours (mm)	12 hours (mm)	24 hours (mm)
0.05	20	101.2	132.4	163.3	191.2
0.02	50	107.7	147.0	186.7	236.2
0.01	100	113.4	159.2	204.7	277.9

Information on spatial variation from the extreme rainfall estimation is crucial for ungauged locations. Accordingly, the manipulation of GIS data and capabilities in providing geographic and statistical representations of space is used to map the extreme rainfall distribution in the study area for the return period at different time intervals. The strategic zone of Kuala Lumpur is as shown in Figure 3.

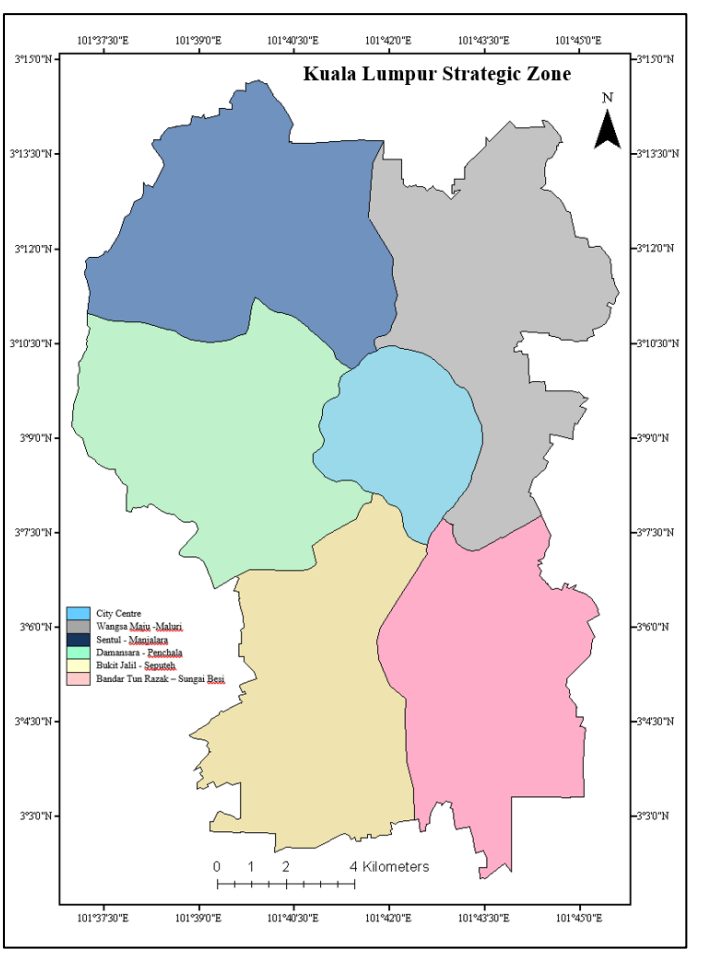

Figure 3. Kuala Lumpur Strategic Zones

Extreme Rainfall for a Return Period of 20 Years

The series of extreme rainfall for a return period of 20 years is shown in Figure 4. The highest estimated rainfall in the one-hour interval is estimated at 101.2mm. The City Center zone maintains the main focus during the 20-year return period, followed by the Damansara-Penchala and the Wangsa Maju-Maluri zones. At one-hour intervals, the three zones estimated extreme rainfall of 98.5mm, 101.0mm and 100.5mm. The other three zones involved Bukit Jalil-Seputeh, Bandar Tun Razak-Sg. Besi and the Sentul-Manjalara showed high rainfall estimates at the intervals of less than six hours, around 101.2mm to 148.6mm. Although these other three zones are not included in the focus zone, it is found that these zones are also vulnerable to flooding.

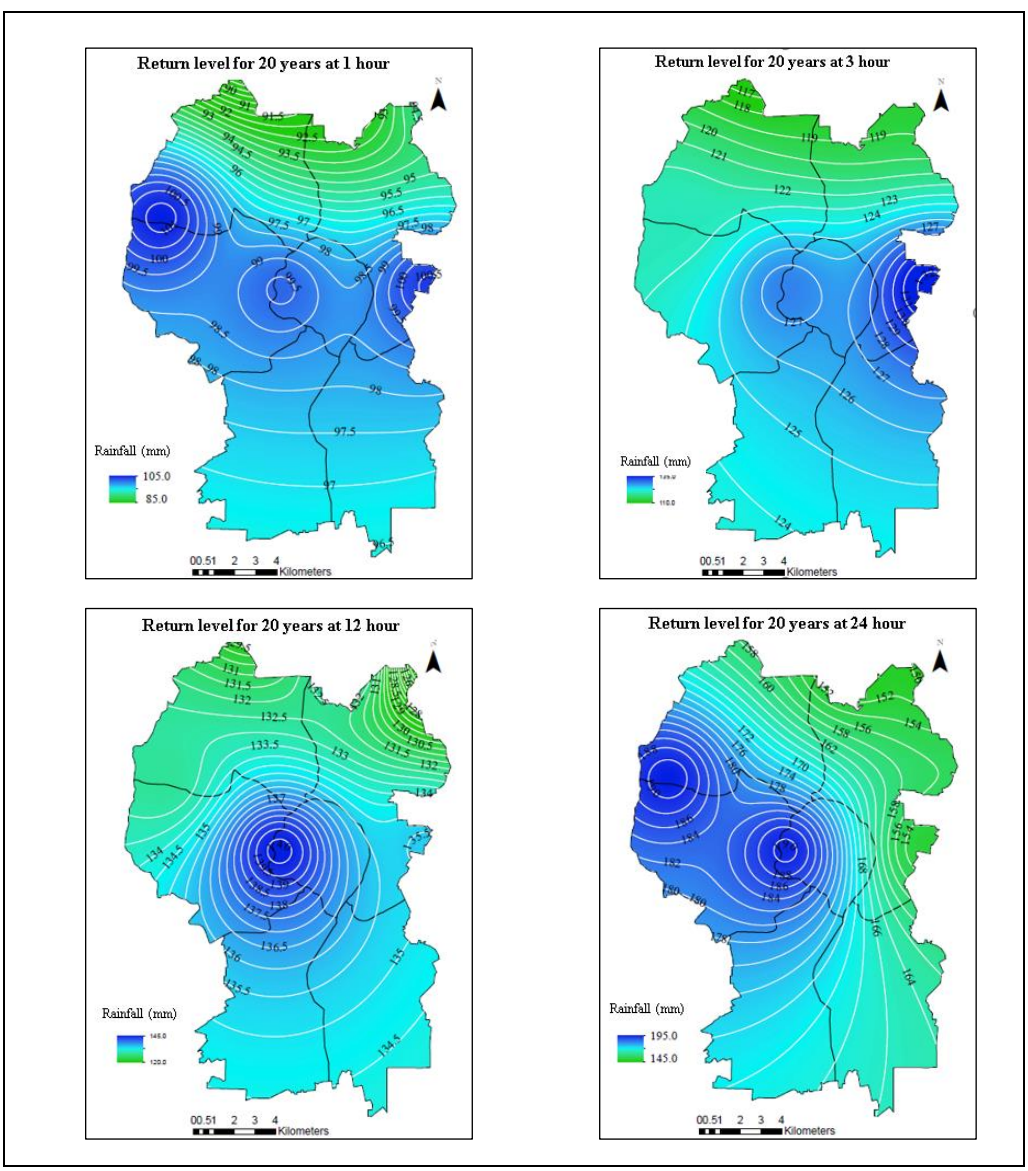

Figure 4. Return Level for 20 Years at Various Hour

Rainfall Design for A Period of 50 Years to 200 Years

Rainfall design for a period of 50 years to 200 years is considered to be in a large range (Johnson & Smithers, 2019). This study is important for high-risk hydraulic structure design as it is more suitable in predicting flooding for a period of 100 years and maximum likelihood (Green et al., 2016). The series of extreme rainfall for 50 years return period is shown in Figure 5. At intervals of less than six hours, the estimated maximum rainfall over a period of 50 years is at 107.7mm to 147.0mm. The City Center zone indicated as a high concentration and high-risk zone of experiencing the phenomenon of extreme rainfall. Next, both Damansara-Penchala and Wangsa Maju-Maluri zones are expected to be the second-highest zones. Over a 50-year period, the anticipated maximum rainfall at more than six-hour intervals ranged from 186.7mm to 236.2mm, with a concentration on the City Center zone.

A return period of 100 years of extreme rainfall over a short interval is expected at 113.4mm to 159.2mm. At intervals 12 to 24 hours, extreme rainfall is expected at 204.7mm to 277.9mm. Following that, the period of 100 years of extreme rainfall is depicted in Figure 6.

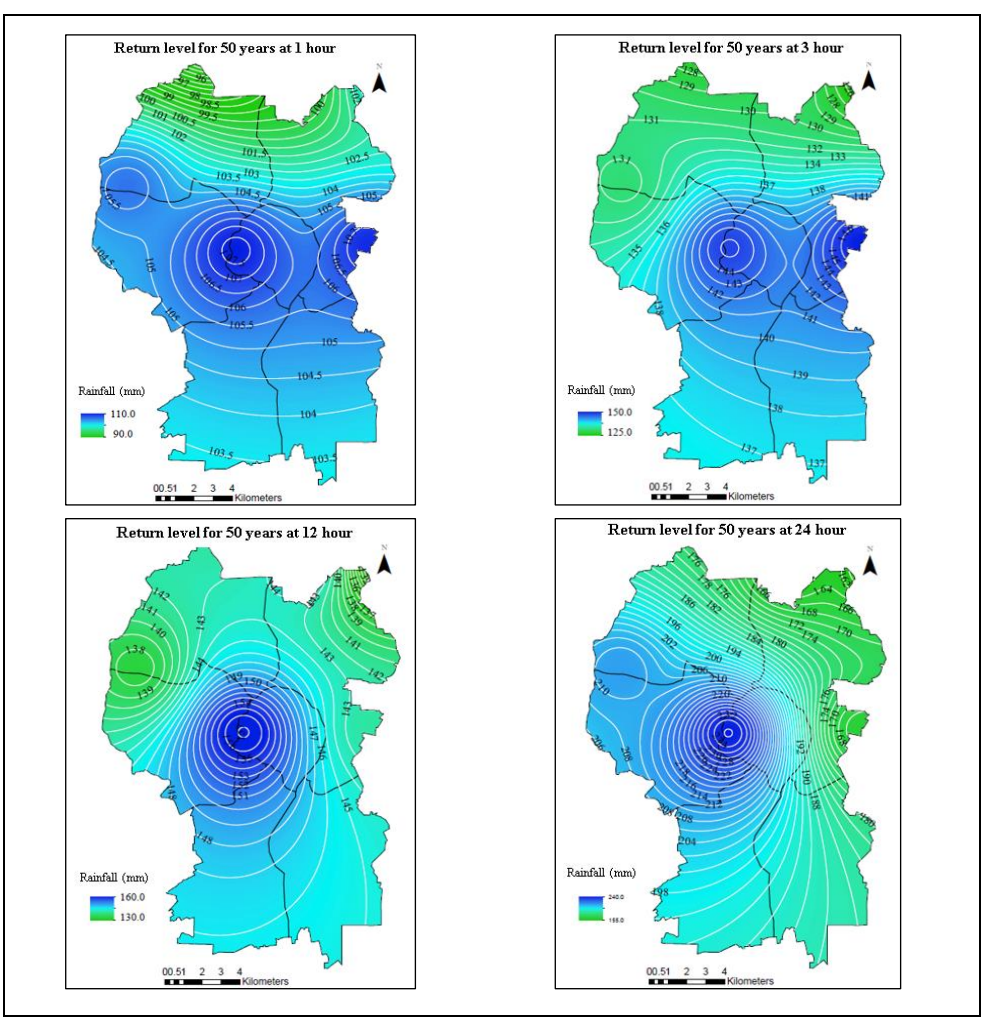

Figure 5. Return Level for 50 Years at Various Hour

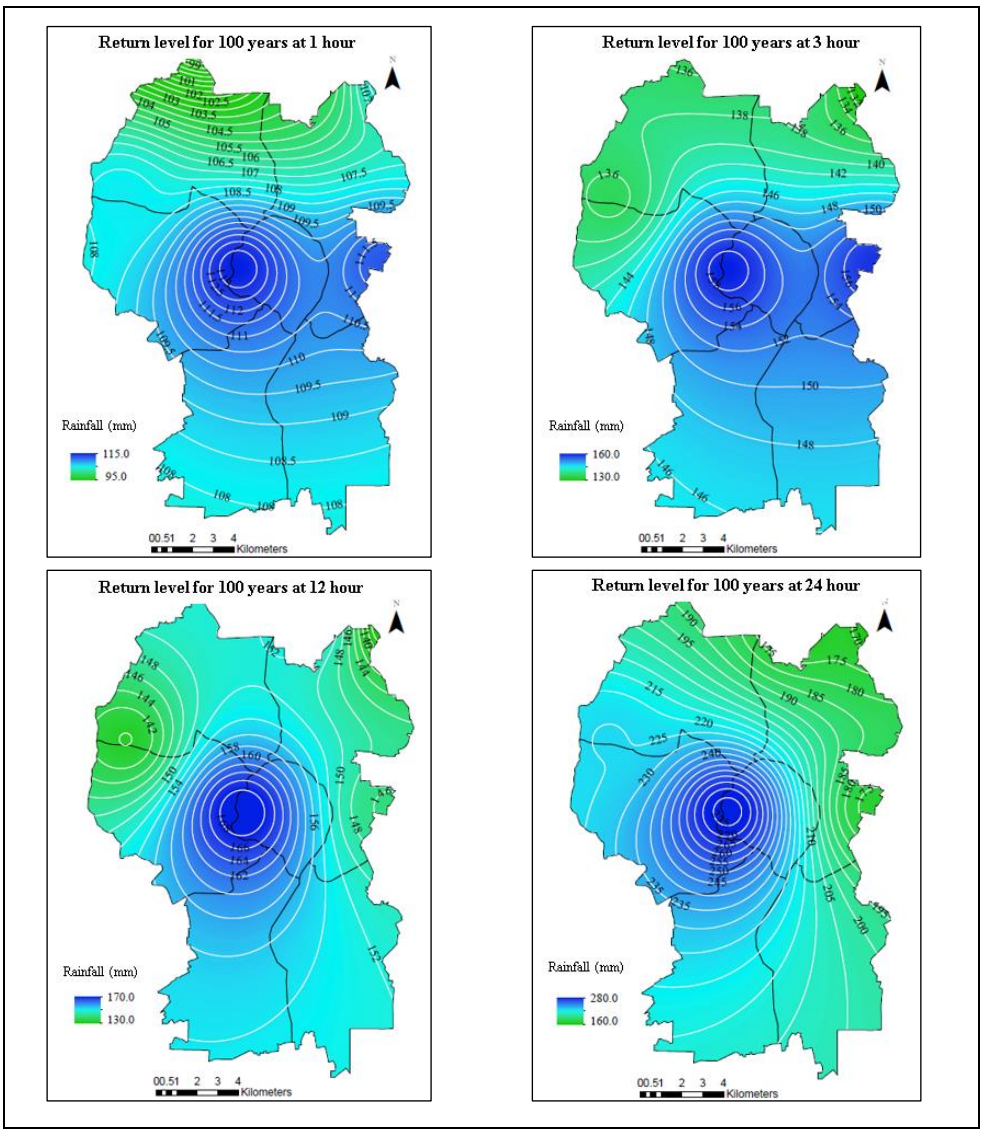

Figure 6. Return Level for 100 Years at Various Hour

CONCLUSION

Return periods maps were developed to evaluate spatial analysis for 20, 50 and 100 years. All values of the extreme rainfall return period in this study formulated three critically critical zones that are vulnerable to flooding. The three zones most at risk of flash floods due to extreme rainfall, namely the City Center, Damansara-Penchala and followed by Wangsa Maju-Maluri. The extreme rainfall map is able to see the extent of spatial distribution, besides being able to estimate the possibility of disasters occurring in the locations. This study also contributed to the identification of stable and non-critical zones for sustainable urbanization.

Mapping the return period from extreme rainfall was performed to gain a better understanding of the data, which is used to determine the long-term risks The extreme rainfall analysis map provided the research area's susceptibility as well as indicated the stable areas

with different types of development and socio-economic activity. This study provided the input on the resilience of new infrastructure designs for the future in particular involving extreme rainfall, critical for risk assessment, encouraging the development of better risk models, and significantly reducing the destruction caused by rainfall-related disasters (Pereira et al., 2010). It will aid in the planning, strategizing, and formulating appropriate policies to mitigate the risks to environmental sustainability.

The focus of the current solution should consider adaptation, vulnerability and resilience to disasters. Specific solutions that should be given attention to structure the solutions by taking into account the balance that can be matched with natural changes. The development of the study required the integration of disaster risk and risk management approaches with comprehensive development design as well as considering several aspects such as social, cultural, ethical, political, economic and legal.

ACKNOWLEDGEMENTS

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DEVELOPER'S PRACTICES AND CHALLENGES IN IMPLEMENTING GREEN PROCUREMENT IN CONSTRUCTION INDUSTRY

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Abstract
Identifying the most critical or affected green practices could lead the construction stakeholders to set up the project's environmental goals and direction through a well-developed framework. Malaysia, however, is still faced with obstacles to changing the thinking of property developers to turn sustainable construction techniques. Despite various benefits associated with green procurement practice, the practice is still in its infancy in the real estate industry. Developers are the most sought outplay a critical role in developing sustainable construction. Green procurement is one of the initiatives introduced to improve sustainability. However, green procurement is still very new. It has not been widely adopted in the Malaysian construction industry — while the practices and challenges that hinder developers from taking green procurement merit detailed investigation. Therefore, this study aims to reveal the potential problems developers face that resist green procurement implementation in the construction industry. Its objective is to identify the current practices of green procurement implementation in the construction industry and determine the developer's challenges in the performance of green procurement in the construction industry. Data collection was done through a mixed method of research, quantitative by questionnaire survey and the qualitative approach by semi-structured interviews. Data analysis was done after collecting data information from the interview and questionnaire session. The findings from this research will provide a valuable reference for assisting relevant developers in mitigating the green procurement challenges in real estate development throughout encouraging and pointing to increased awareness, practice, and implementation of green procurement by practitioners in Malaysia. It envisaged that the study would provide the basis for future research into green procurement practices for construction projects in Malaysia and beyond.

Keywords: *Green procurement, construction industry, developer's challenges.*

INTRODUCTION

Prime Minister launched the Construction Industry Transformation Programme 2016-2020 (CITP) at Putra World Trade Centre (PWTC) on 10 September 2015. The program noted three environmental, social, and economic problems: not resistance to natural disasters, high energy consumption surplus of buildings, and increased waste dumping and demolition. The Construction Industry Development Board (CIDB) plays a part in the evolution and modernization of Malaysia's construction industry. CIDB is also involved in addressing and assisting stakeholders on sustainable development (CIDB, 2019b). Under the country's mission to preserve and stabilize the long-term economic value of the surrounding environment, it should give organizations excellent possibilities to adopt and implement green procurement strategies in their society to minimize negative environmental and social company impacts. Because organizational culture carries values, attitudes, and beliefs, it is subjective to the organizational environment and interacts with relations and communications (McMurry et al., 2014). Green investment may be regarded as the primary tool for comprehensive green growth as a means of socio-economic development (Wong et al., 2016). They added that green investment contributes to environmental improvement and

enhancement, in line with Gross Domestic Product (GDP) growth and wealth-building (Khan et al., 2018).

The construction industry has contributed significantly to the Malaysian economy due to its extensive linkages with other manufacturing, construction, and financial services industries (Klufallah et al., 2019). Building and sustainability issues are linked intrinsically because the industry is essential in reducing non-renewable resources (Khan et al., 2018). Therefore, green procurement was implemented to deal with environmental issues as efficient instruments and one of the initiatives introduced to improve sustainable development (Buniamin et al., 2016). Green procurement is gradually being introduced in construction development to ensure sustainable, safe, and cost-effective construction industry practices (Bidin et al., 2018).

Given that Malaysia plans to expand construction projects, it is vital to set out a greener route to create a sustainable future beyond any doubt. Therefore, one of the initiatives is establishing green procurement, which forms part of the government initiative MyHijau and emphasizes the Malaysian economic planning programme (Bohari et al., 2017). It is supported by Zainordin et al. (2016) the pressing demand for green, safe, and economic improvement in industrial practices has made it a significant concern of the building industry to facilitate the broader implementation of green procurement in building developments. According to Ruparathna & Hewage (2015), to embark on green procurement practice, building stakeholders should be prepared, particularly about environmental issues, to alter their attitudes and cultures by exploring new land to take on fresh thoughts and methods.

The preceding issues show that the level of implementation of green procurement in construction must still be improved and reviewed from time to time. It will be essential to disclose the potential difficulties facing developers resisting green procurement in the building sector and require all building experts – particularly development professionals, who play a crucial role in the development process. The developer is also the initiator of the project and has the privilege of influencing project management generally. Encouraging green procurement implementation can help developers succeed by taking measures needed to meet the green procurement challenges. The developer is the one who has played a significant role in developing and managing a project. Due to the circumstances, this research focuses on developers' difficulty in applying green procurement for past and current projects. This study determined the magnitude and benchmark for further improvements to research.

LITERATURE REVIEW

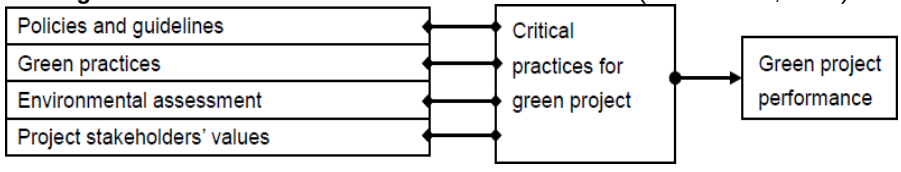
Green Procurement Practice

Practising green procurement in a construction project implies that the organization should be accountable for minimizing the effect of operations on the environment throughout the project stage (Khan et al., 2018). Where management support such as continuous assessment of green procurement is essential to green procurement practices (Alberg, 2015). Green procurement was gradually implemented in the construction of buildings to ensure the improvement of practices in the construction sector viable, safe, and cost-effective. Companies or organizations generally have individuals who have different methods and work practices. Generally, the organization describes some work in manuals, procedures, and work descriptions. Changes in policies are essential to introduce green procurement; existing

procurement methods, for instance, are altered, or green procurement merged with current practices (Bidin et al., 2018). Implementing green procurement can limit the negative consequences of the environment and surroundings of human beings and helps in obtaining business benefits to the company by reducing environmental handling costs (Saferi et al., 2018). According to green procurement practices, the environmental criteria should be considered from the early stage of planning.

According to Bohari & Bo (2015), in green procurement practices, they have identified four primary categories, namely policies and guidelines, project management, environment evaluation and assessment, and project stakeholders' values. The framework of the green procurement practices of these four (4) main categories can be described in Figure 1.

Figure 1. Framework of Green Procurement Practices (Bohari & Bo, 2015)



Green procurement practices involved policies and guidelines at the macro and micro levels, industry standards, and government and project incentives. The government can use the top-bottom approach to persuade stakeholders to adopt green practices by formulating policies and guidelines. Besides that, industry standards such as eco-labelling programs and implementation of ISO14001 could be necessary for green procurement practices.

According to Ruparathna & Hewage (2015), construction procurement is multi-dimensional. It incorporates the diverse aspects of contract strategy; contract conditions; performance; culture, sustainability; economics; political environment; learning, leadership, satisfaction, self-esteem, and motivation. As described by Sanchiz et al. (2014), the construction procurement process can be classified into three levels of tasks. It starts with strategic planning, then projects development and followed by project implementation, as shown in Figure 2.

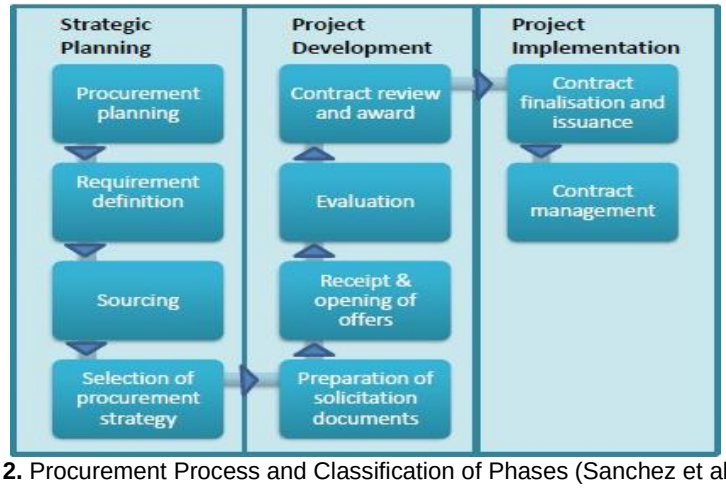


Figure 2. Procurement Process and Classification of Phases (Sanchez et al., 2014)

Generally, it involves the six primary activities that are linked to the general procurement process and set out the actions and deliverables associated with the process: establishing the objective, deciding on procurement strategies, soliciting, and evaluating tenders, awarding, and managing contracts, and confirming compliance with the requirements (Bohari & Bo, 2015). The application of green procurements in construction requires an account of the direction of the raw materials, transport, packaging, storage, processing and disposal or recycling of the product in all lifecycle stages (Bidin et al., 2018). Green Procurement includes purchasing products, policies, and directives with minimal or positive environmental impacts. According to Saferi et al. (2018), each organization's purpose may consider purchasing materials from the green supplier that include environmental measures, such as using recycled material. According to Chin et al. (2015), the 3Rs concept consists of reuse, recycling, and reduction. It includes paper & parts containers, placing purchasing orders through email, using eco-labelling of products, ensuring suppliers' environmental compliance certification, and conducting auditing for suppliers' internal environmental management.

Various green processes can be established to translate policies and strategies into proactive initiatives to enable the overall goals and objectives to be met and emphasize green procurement concepts in sustainable construction. Sanchez et al. (2014) described the procurement stages in the study are a processing unit at the task level.

Challenges of Green Procurement Implementation

The implementation of green procurement is still in its introduction phase and requires improvement in organizations' performance through green procurement practices. It is because developers face various challenges and regularly discover it hard to switch their method of strategy and organization (Appolloni et al., 2014; Buniamin et al., 2015; Rais et al., 2018). A lack of knowledge among stakeholders is crucial for green procurement implementation (Rais et al., 2018). This also refers to the application of sustainability procedures and, in specific, the adoption of green procurement procedures. Therefore, businesses must define the obstacles to green procurement within their organizational limits and with their vendors (Appolloni et al., 2014). This might happen as the procedure, and necessary guideline for monitoring the environmental requirement and related technology is often insufficient to support its implementation. In addition, consistent indicators to assess the performance of green procurement are yet to be available (Buniamin et al., 2016).

According to Appolloni et al. (2014), the assessment obstacles for green procurement should be outlined in detail in terms of the perspective of the size of the business, given that there are significant variations between big and small companies with a greater likelihood of engaging in sustainability. Helping suppliers recognize the importance of resolving environmental issues and supporting them in installing their improvement initiatives is a significant issue that companies must address today. Observe that 'greening' different phases of the supply chain led to an integrated green supply chain, leading to competitiveness and better economic and operational performance. Rais et al. (2018) highlighted that their study had classified the possible challenges in implementing green procurement, including knowledge, training, awareness, policy, commitment, demand, integration, time, cost, and availability. As highlighted by Khan et al. (2018), the possible challenges for sustainable procurement in the construction sector can break up into four types.

Political

In line with Khan et al. (2018), the government has a vital role in promoting construction sustainability. With the assistance of legislation and regulations, sustainable construction can fully be enforced. Based on various studies, many practitioners believe that government-assigned regulations and legislation are essential to applying green procurement in the construction industry. Even though several environmental-focused acts have occurred, such as the Environmental Protection Act, Clean Air Act, Energy Policy Act, they have been ineffective due to a lack of enforcement and surveillance. However, Roman (2017) has disagreed because green procurement implementation can be challenging for technical and organizational policy navigation elements. The lack of legislative mandates or incentives at the local, state, and national levels is a severe impediment to sustainable practice.

Environmental

According to Bohari & Bo (2015); Buniamin et al. (2016); and Rais et al. (2018), lack of stakeholder understanding is the main challenge in implementing green procurement. This medium is because many practitioners believe that developers have little knowledge or experience in green procurement or understand the notion of green procurement and the significance of green procurement in the construction sector, as highlighted by Khan et al. (2018). Managers do not know how sustainability issues can be incorporated into the procurement process (Roman, 2017). Buniamin et al. (2016) added that the number of skilled employees is still insufficient to handle green procurement.

Economic

According to Montalban, Ballesteros-Perez, Sanz, & Pellicer (2017), the main obstacles to sustainable procurement worldwide are economic limitations. Cost problems are a prominent factor in the implementation of green procurement for contractors and developers. It has often been considered that sustainability is costly. This medium is because the strategy to construction and the choice of materials is distinct from a standard construction (Khan et al., 2018). However, sustainable construction procurement does not require increased capital costs (Khan et al., 2018; Rais et al., 2018).

Social

According to Djokoto, Dadzie, & Ohemeng-Ababio (2014), resistance to change is an essential obstacle to green procurement. This resistance to change outcomes in a lack of demand from customers and stakeholders in the building project leading to supply impact. Customers' demand and readiness are essential directions for green procurement growth. Customer consciousness is a significant driver for more sustainable practices. Many individuals always do their job in some respects; it is difficult for them to change their thinking, particularly the traditional construction techniques performed, and equipment used by individuals more frequent (Khan et al., 2018).

As mentioned by Chan et al. (2017), it is only a perception that there is no widely accepted method for identifying the effectiveness of existing sustainable assessment tools. This medium, supported by Rais et al. (2018), is part of the obstacle because of the absence of

practical instruments and data for applying green procurement, such as handbooks or internet instruments. To cope with a scenario, they need to produce more extensive instruments. Wong et al. (2016) mentioned that the management commitment hampers the implementation of green procurement. This medium supported by Buniamin et al. (2016), who underlines the lack of financial and time management commitment that slows green practices. In applying green procurement, all organizational levels must be committed by the leadership and the procurement representatives (Khan et al., 2018).

RESEARCH METHODOLOGY

The methodology of this study combines a literature review and a survey questionnaire, and a semi-structured interview. The preliminary stage of this research involved studying and understanding the topic area and identifying the scope and objectives of the research proposal. The further action was to identify project data and conduct a study for further research details. In this action, a literature review was carried out to collect the relevant information based on secondary data from published resources such as reference books, seminar papers, articles, journals, and related websites. Then continue with utilizing a questionnaire to collect primary data to meet the study's objectives, revealing the potential problems faced by developers that resist the implementation of green procurement in the construction industry.

An exploratory research approach was conducted to achieve the research's aim: to gauge the challenges factors faced by developers that resist the implementation of green procurement in the construction industry. A questionnaire survey through a close-ended questionnaire was implemented. This research applied the purposive sampling method in obtaining the data among the housing developer firms. The related respondent to the research has experts presenting the characteristics and expertise appropriate for this study. Thus, the developers chose from the list of companies registered with the Real Estate and Housing Developers' Association (REHDA) for updated 23 March 2019 records, about 311 registered Developers in Selangor (REDHA, 2019). The researcher uses Krejcie & Morgan (1970) model of sampling to estimate how many questionnaires to distributed to registered developers.

Quantitative research through the online survey can cover a wide geographical area. The method of distribution is being submitted by emailing and directly walk into the company of the respondents. Before the questionnaires are distributed, the researcher will inform the respondents that the questionnaires will be sent to them and give them a phone call to ensure that they have answered the question to be collected. All the data collected from the secondary and primary data gathered from the semi-structured interview and questionnaire conducted early beforehand will be analysed together. The data collected will be analysed using Statistical Package for the Social Sciences (SPSS) for the questionnaire survey. The frequency and the descriptive analysis were used to generate the frequencies, standard deviation, and mean for the analysis purpose of the questionnaire. For the interview survey, the data collected will be analysed using thematic content analysis. This method of analysis including transcription, checking, analysing, interpretation and validation.

The qualitative research methods approach with selected developers having experience in green procurement conducted in-depth semi-structured interviews. A total of eight (8) developers were requested to interviewed. Only three (3) Selangor Developers registered with

Real Estate and Housing Developers' Association (REHDA) feedback and agreed to the request and participated in the interview. Before the interview session, the interview questions are being prepared and forwarded to the participants; hence the participants can briefly understand the aims and objectives of the research. The interview question was prepared based on the literature review findings towards achieving the research objectives. All participants have more than ten years of experience. The data analysis made subsequently to extend and validate the outcome from the recorded interview session.

The researcher will interview experienced developers who have implemented green procurement and stop until they meet the repeated feedback. The critical profiles of the interviews at least were involved in one project for green construction from the planning stage until handing-over. For this study, semi-structured interviews using a face-to-face and telephone conversation approach method were used to get the data. This study provides extensive feedback on the questionnaire, the adequacy of the questionnaire, and the face-to-face validity of the questionnaire—and interview protocol provided for structuring interviews to ensure the instrument's reliability.

RESULTS AND DISCUSSIONS

Types of Procurement Used in Green Building

Table 1 shows that 37.7 per cent of the respondents pointed out that their projects used traditional methods as a procurement route. In contrast, around 35.8 per cent used to design and build, and 26.4 per cent used construction management. This medium reflected those traditional methods are the most common way of procuring green projects in Malaysia.

Table 1. Type of Procurement used in Green Project

Type of Procurement	Frequency	Percent	Valid Percent	Cumulative Percent
Traditional procurement	20	37.7	37.7	37.7
Design and build	19	35.8	35.8	73.6
Construction Management	14	26.4	26.4	100.0
Total	53	100.0	100.0	

Green Procurement Practices for Construction Project

Table 2 shows that the respondents have considered all twenty-one (21) statements regarding green procurement practices, with an implementation level of the above mean value of 3.0. From the list of green procurement practices in Table 2, four main characteristics regarding green-oriented procurement practices are identified in Table 3. The results reveal that the highest implementation practices are stakeholders' value, policies and guidelines, green practices, and environmental evaluation with a mean value of 3.4528, 3.3774, 3.2972 and 3.2642.

Table 2. Ranking of Green Procurement Practices for Construction Project

Green Procurement Practices	N	Minimum	Maximum	Mean	Std. Deviation
Project stakeholder commitment	53	1.00	5.00	3.6226	.94516
Client commitment	53	2.00	5.00	3.6038	.94746
Stakeholder ability to understand bigger picture of green construction	53	2.00	5.00	3.5472	.88938
Compliance with government regulation and law in term of environmental protection	53	2.00	5.00	3.5472	.93162
Project stakeholder competencies (technical)	53	2.00	5.00	3.5283	.79913
Getting support from supplier	53	2.00	5.00	3.4906	.82328
Green specification (e.g. green design, green products, green cost)	53	2.00	5.00	3.4340	.84374
The industry standard (e.g. Environmental Management Systems (EMS), ISO 14001, eco-labelling etc.)	53	2.00	5.00	3.4340	.77234
Waste management principle (e.g., recycling)	53	2.00	5.00	3.3962	.92694
Policy on incentives and reward (e.g., tax exemption)	52	1.00	5.00	3.3846	.93208
Sharing experience among stakeholders in project	52	1.00	5.00	3.3654	.95031
Conducting In-house training/briefing	53	2.00	5.00	3.3585	.83423
Formulation of policy and guidelines at project level to suits project needs and capability	53	2.00	5.00	3.3585	.83423
Pre-qualification based on knowledge in green construction	53	1.00	5.00	3.3396	.87582
Formulation and enforcement of government regulation and law	53	1.00	5.00	3.3396	.83074
Project's internal audit (e.g., tender selection)	53	1.00	5.00	3.2453	.91789
Acquiring external collaboration or training	53	1.00	5.00	3.2264	.89101
Benchmarking with industry standard (e.g., eco-labelling)	53	2.00	5.00	3.2075	.81709
Green process (e.g., e-procurement)	53	2.00	5.00	3.2075	.90636
The application of the life cycle analysis (LCA)	53	1.00	5.00	3.1509	.90716
Encouraging and considering public feedback and opinion	53	1.00	5.00	3.0566	1.02685

The results of this study indicate that the most current practices were stakeholders' value with a score of 3.4528, which consist of three best practices, i.e., project stakeholder commitment, client commitment and stakeholder ability to understand the bigger picture of green construction. As mentioned in the literature review, stakeholder values refer to the stakeholder's capabilities, awareness, and interest in adopting green practices. For a construction project, stakeholder plays an essential role in achieving project objectives (Bohari et al., 2017).

The results of the semi-structured interviews also showed that all the respondents mainly highlighted that they associate the green procurement practices, i.e., policies and guidelines and stakeholders value, with the need to integrate environmental protection with construction. They agree that this derives from the awareness that everyone should be involved in the global commitment to address climate change.

Table 3. Summary Characteristics of Green Procurement Practices for Construction Project

Green Procurement Practices	N	Minimum	Maximum	Mean	Std. Deviation
Stakeholders	53	2.11	5.00	3.4528	.67229
Policies	53	2.00	5.00	3.3774	.63667
Practices	53	2.00	5.00	3.2972	.75488
Evaluation	53	1.50	5.00	3.2642	.77276

This result may be explained by the fact that Saferi et al. (2018) indicate that the project's apparent outcome is affected by stakeholders' perception towards the project and influence the accomplishment of the goals set by the association. This medium because perceptions of stakeholders over project outcomes also change occasionally. In the construction context, green performance depends on stakeholder involvement, whereby their commitment significantly impacts green performance (Zainordin et al., 2016). Besides, there have been some concerns from the developer perspective when dealing with the project team in performing the construction project's progress. This medium is within a considerable period of sustainable development, including the designers, contractors, engineers, researchers, governmental authorities, or specific occupiers and clients (Lorenz & Lutzkendorf, 2011). Thus, Samantha (2008) stated that the developer must work closely with consultants to produce good projects.

Consultants can better carry out their responsibilities to the owners or developers. With increased awareness and understanding, the developers can benefit from having consultants involved in the construction process. These results indicate that the construction professionals in Malaysia must adopt and implement green practices in a project towards the green-oriented operation in an organization.

However, the current study's findings do not support the previous research that has sought to address the low level of knowledge in green procurement since green procurement is still a new concept in Malaysia (Rais et al., 2018). Despite various benefits associated with green procurement practice, the practice is still in its infancy in the real estate industry. This medium is because green procurement practice in real estate development is more immature (Shen, Zhang, & Long, 2017). Because of the increasing worries, it is comparatively costly to go sustainable (Asia Green Building, 2014). As Rais et al. (2018) are concerned in their study, the implementation of green procurement is still in its introduction phase, and stakeholders face various challenges such as lack of knowledge and awareness on the green procurement concept. According to Alberg Mosgaard (2015), it can be supported by an analysis of the causes of specific procedures in each subsidiary, the development of green procurement procedures and the use of this information to suggest ways to improved practice.

Challenges in Implementing Green Procurement

Table 4 shows the ranking of challenges in implementing green procurement by the respondents. From that result, the researcher has classified the question according to the characteristics of green procurement challenges.

Table 4. Ranking of Challenges in Implementing Green Procurement

Green Procurement Challenges	N	Minimum	Maximum	Mean	Std. Deviation
Perception that greens product would be more expensive	69	2.00	5.00	4.1159	.86664
Lack of incentive for companies to implement green procurement	69	2.00	5.00	3.9275	.98993
High cost of green product and services	69	2.00	5.00	3.8986	.84270
Lack of awareness on the green procurement concept	68	2.00	5.00	3.8824	.87297
Lack of top management commitment including money and time	69	1.00	5.00	3.7536	.91404
Insufficient integration and link up in the industry	69	1.00	5.00	3.7101	.84194
Procedure to implement green procurement are time consuming	68	1.00	5.00	3.6912	.88533
Lack of enforcement by government to implement green procurement	68	2.00	5.00	3.6912	.90203
Insufficient qualified staff to handle green procurement	67	2.00	5.00	3.6716	.78602
Poor demand for recyclable material	69	1.00	5.00	3.6232	.94092
Lack of knowledge	68	1.00	5.00	3.6176	.93089
Lack of practical tools and information	69	2.00	5.00	3.5942	.82816
Lack of training for procurement officers	68	1.00	5.00	3.5735	.88632
Limited supply for green product	69	1.00	5.00	3.4928	.91753
Insufficient policies and regulation promoting green procurement	69	1.00	5.00	3.4638	1.05133
Insufficient research and development	69	1.00	5.00	3.4348	.97737
Lack of proper guideline in implementing green procurement	67	1.00	5.00	3.3284	1.06441

There are four main factors and challenges for green-oriented procurement in the Malaysian construction industry, as shown in Table 5—the arrangement of the results in ranking manners in great perspective.

Table 5. Summary Characteristics of Challenges in Implementing Green Procurement

Green Procurement Challenges	N	Minimum	Maximum	Mean	Std. Deviation
Economic	69	2.00	5.00	3.9807	.78774
Environmental	68	1.50	5.00	3.6801	.73155
Social	69	1.80	5.00	3.6396	.70236
Political	69	1.50	5.00	3.4819	.81835

Based on Table 4, the results show that the respondents have considered all seventeen (17) statements regarding green procurement challenges, which have a disagreement level of the above mean value of 3.0. From the list of green procurement challenges in Table 6, there

are four critical characteristics regarding green procurement challenges face by the developer identified in Table 5. The results reveal that the developer's highest level of disagreement of challenges in implementing green procurement is economic, environmental, social, and political, with a mean value of 3.9807, 3.6801, 3.6396 and 3.4819, respectively. The results from the semi-structured interviews also support that the main challenges that hinder developers from taking green procurement are economic and environmental. The respondents agree that implementing green procurement in Malaysia is still in its infancy and faces several challenges.

This study indicates that the most challenges were economical with a score of 3.9807, which consist of the perception that green products would be more expensive, lack of incentive for companies to implement green procurement, and high cost of green products and services. This finding is consistent with Montalban et al. (2017). The main obstacles to sustainable procurement throughout the world are economic limitations. Cost problems are a prominent factor in the implementation of green procurement for contractors and developers. This medium is because the strategy to construction and the choice of materials is distinct from a standard construction (Khan et al., 2018). However, sustainable construction procurement does not require increased capital costs (Khan et al., 2018; Rais et al., 2018).

CONCLUSION

This research presents the green-oriented procurement in the construction industry that resulted from the research findings. These research findings can benefit the industry towards enhancing the green procurement implementation, especially in our country since many environmental issues have become worse lately. All parties or stakeholders need to take a high responsive action to implement sustainable construction due to passive movement undertaken by certain parties, primarily developers. Developers is the most sought outplay a critical role in the development of sustainable construction. Green procurement is one of the initiatives introduced to improve sustainability. It is highly recommended that the findings from this research provide a valuable reference for assisting relevant developers in mitigating the green procurement challenges in real estate development, encouraging, and pointing to increased awareness, practice, and implementation of green procurement by practitioners in Malaysia. Thus, the developers in Malaysia focus on demand in the market and economic variables until environmental concerns are ignored. Due to higher initial costs, sustainable construction practices can be considered a disruption to such activities to achieve a short-term economy. Therefore, the decision must create a financial equilibrium in the long term to strike an economic, social, and environmental balance towards sustainable construction.

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EXPLORING THE GOVERNING STRUCTURE CHALLENGES FOR THE DEVELOPMENT OF WAQF LAND IN MALAYSIA

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Abstract
As one of the charitable instruments in the Islamic religion, waqf sector in Malaysia has been placed under the purview of the State Islamic Religious Councils (SIRCs), who hold the authority as the waqf sole trustee. Waqf has supported various efforts to enhance the socio-economy of the people and retain the Muslims' wealth. Since waqf has been institutionalised and centrally administrated by the SIRCs, it is exposed to some of the governing structural challenges. Literature search has able to find various related challenges and being group into three, namely the legislations, administrations, and obligations. Interviews with all fourteen SIRCs had been conducted to present the empirical evidence. The findings from the interviews were consistent with the literature and supported the discussion. The study had also posed the concept of Special Property Development Entity (SPDE) during the interviews to see the probability of the concept to partially mitigate the governing structural challenges. But, there were mixed responds amongst the informant who were unsure the probability of success for this concept. Overall, the study was able to achieve its objective to explore the governing structural challenges that possible to influence the progress of waqf development in the country.

Keywords: *Waqf, Land Development, Governing Structure Challenges, Malaysia.*

INTRODUCTION

As one of the core activities in the real estate sector, land development has been recognised as critical in developing the physical needs of the civilisation. Land development has been segmentized into many segments according to types, purposes, geography, legislation, culture and many more. These segments also including the land development for the religious setting, which is significant in shaping the facet of the social structure. The fact that Islam is the religion of the Federation in Malaysia has seen that 63.5% of its population in year 2020 are Muslims and possesses more than 30,888.89 hectares of waqf land throughout of the country (Department of Statistics Malaysia, 2022; Yayasan Waqaf Malaysia, 2016). Waqf is a perpetual charity instrument under the purview of Islamic laws and exist in the form of real estate assets and other non-real estate assets. Waqf in the form of real estate assets, especially the land has been commonly founded and developed in various purposes and benefits for the dedicated beneficiaries. Many evidence have shown that waqf is incredibly dynamic in playing its significant role in supporting the socio-economics of the population in Malaysia and worked perfectly good in the third sector alongside other charity and voluntary organisations (Mohd Arshad & Mohamed Haneef, 2017).

Waqf was traditionally managed by its founder and later entrusted to any respectable people to manage the waqf after the decease of the founder. However, this traditional management was facing various issues related to mismanagement, misuse of waqf assets, qualification of the manager, unskilled manager, unstructured management approach and many more (Mar Iman & Mohammad, 2014; Hassan & Shahid, 2010; Abdel Mohsin et al., 2016; Shulthoni & Md Saad, 2018; Sait & Lim, 2006). Waqf in Malaysia was also facing almost the same situation, which lead to its reform and institutionalization after the formation of the State Islamic Religious Councils (SIRCs) and being regulated through enactments all through the 20th century (Syed Abdul Kader, 2016; Syed Abdul Kader & Mohamed, 2017; Mahamood, 2011). In fact, it was first being institutionalized by the British in Penang in 1905 through the formation of Mohammedan and Hindu Endowments Board (Sinha, 2011). It was a long transition period for waqf in Malaysia and constantly facing challenges. Now, after the institutionalization, waqf is administered by the fourteen SIRCs of every state in Malaysia including Federal Territory. As being empowered by the Federal Constitution, respective states' Islamic administration enactment, and states' waqf administration enactment, the SIRCs are holding the power as the sole trustee for waqf and responsible for its administration in the respective states' territories. Although the institutionalization of waqf as of now is seemed to overcome the problems of traditional waqf management, (Abdel Mohsin, 2010; Abdel Mohsin et al., 2016; Syed Khalid, 2014) have viewed that the waqf management issues are still exist and being complicated by certain governmental restrictions. In line with that, the governing system in this country also contributes to several structural governing challenges to the waqf administration such as the availability of bureaucracies at all administration levels, the governing of various laws and statutes, and the interaction with so many agencies.

To add to the above, SIRCs are not managing waqf only to fulfill the social responsibilities but have also been balanced with commercial activities to generate more incomes and produce larger benefits to the beneficiaries. Many waqf lands have been developed as commercial purposes to explore their optimum potentials and any profits or returns from the development will be channelled to the beneficiaries. However, the efforts are hindered by the structural challenges, which made the SIRCs having difficulties to effectively move and compete in the open market. With the focus on the development of waqf land, this paper is exploring the existing governing structural challenges that possible to give threats to the overall progress of waqf development in the country. It would generate some ideas for the SIRCs and waqf market players to be aware and strategize their actions.

GOVERNING STRUCTURAL CHALLENGES

Regarding to this paper, the structural governing challenges can be referred as any hindering factors originated from the formal rulings and policies in the public policies and implementation. In relation to that, shariah rulings are also crucial to govern waqf practices and ensure the administration is following the stipulated fiqh. Therefore, waqf is bound to several shariah rulings stipulated under the Islamic jurisdiction and countries' legislations.

In the introduction of this paper, it has been pointed out that waqf is placed in the third sector and being regard as working very well in that sector. However, its management has been put under the SIRCs, which established by the enactment with several core responsibilities and consequently become the state statutory body. Although not fully a

government agency, the SIRCs are bound to certain administrative policies and bureaucracies as stipulated in the states resulted all the 14 SIRCs in Malaysia are having authority to manage and develop waqf lands with different strategies. Despite of their differences, they cannot avoid from facing the same structural governing challenges which can be categories into three, namely the legislation, administration, and obligations that will be explained in the following.

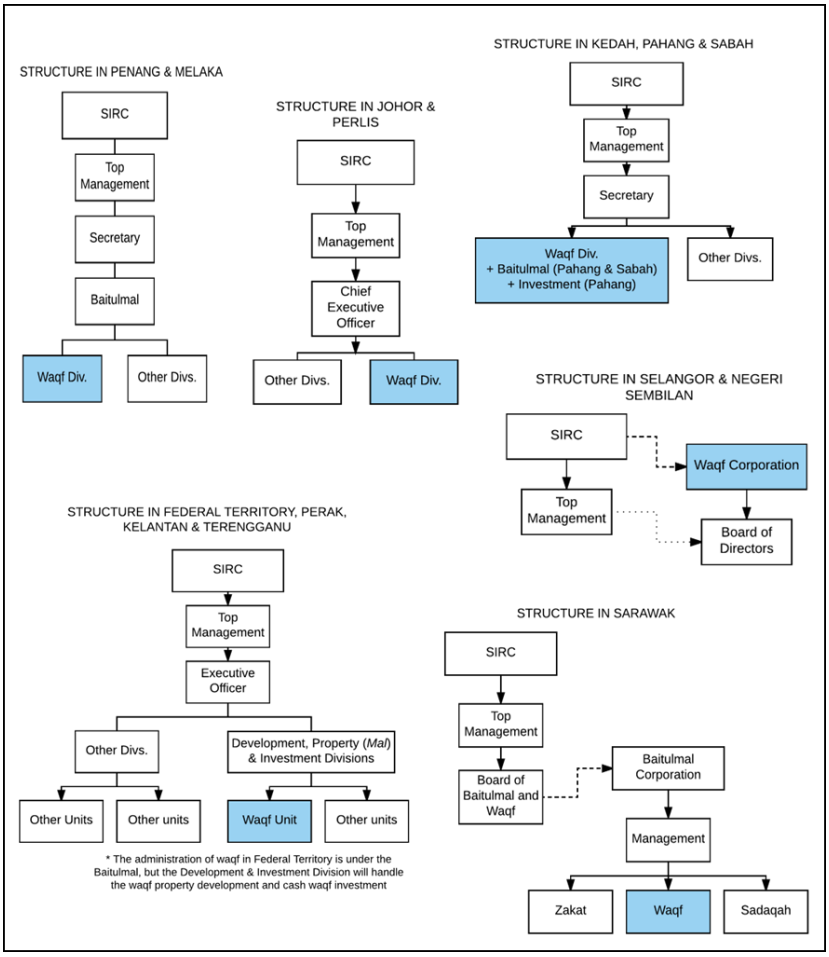
Legislation Challenges

Place within the Federalism concept, List II of the 9th Schedule of the Federal Constitution has listed Islamic religion matters including waqf under the states' affairs, which authorized the power of the state to administrate waqf independently (Syed Abdul Kader & Mohamed, 2017; Syed Abdul Kader & Md. Dahlan, 2017). Federal agencies cannot involve directly in the administration of waqf in the state although highly determined to ensure the success and willing to allocate some development budget from the Federal government (Abdul Manaf, Syed Abdul Kader & Mohamad, 2018). Furthermore, the states' Islamic administration enactments and states' waqf enactments have galvanized the SIRCs' position as the waqf sole trustee in the states (Mahamood, 2006, 2011). This status quo has made the SIRCs to possess much-controlling power and influential in the waqf development decision and progress in the state (Ahmed, 2019). The boundary of power has undeniably made the SIRCs to be sensitive to the state boundaries and encroachment by any parties to interfere in their waqf affairs would not be welcomed. This would be a reason of why waqf in Malaysia never seen as a coherent whole and country-unified institution (Çizakça, 2000, 2008). SIRCs in every state has different strength and capability to progress and perform, which become the constraints to govern, conduct and control waqf related matters towards the development of the country's overall waqf performance.

Undeniable that the legal provisions for waqf are currently insufficient and not comprehensive to exercise uniformity (Mohamad, Syed Abdul Kader & Ali, 2012; Syed Abdul Kader, 2016). Also, quite regularly that the registration, interpretation, execution and development of waqf assets or land have been sidelined, restrained and mistreated by other conflicting laws and agencies (Omar, Md Yusof & Manaf, 2014; Mat Rani, Sayin, Abdul Latiff, Ishak, & Othman, 2014; Mohamad et al., 2017; Abdul Majid & Said, 2014; Syed Abdul Kader & Mohamed, 2017). Lack of comprehensive and unchallenged laws for waqf would make its management and development expose for the debates and disputes when involved in any conflict. These have consequently resulted the registration, development approval process, and execution for waqf land development to be lengthy, costly, inconsistent and unstandardised. The process would require for experience and knowledgeable people in the SIRCs to do the communication and negotiation to solve the conflict and safeguarding the interest of waqf.

Administration Challenges

All SIRCs in Malaysia would have the authority to set their organisations according to their strategy. Every setup will have different number of staff, competency, policy, and management strategy to ensure effective function of their organisation. This subsequently affect the hierarchy of waqf unit, division, or department in the organisation. Overall, there are six different structures of waqf unit, division or department in different SIRCs (refer Figure 1).



(Source: Mohamed Azmi, 2020)

Figure 1. Administration Structure of Waqf in SIRCs

The hierarchy of the waqf unit, division or department would influence the authority level and its concentration of function (Mohamed Azmi, 2020). Usually, higher position in the organization would associate with the important and strategic function of a particular unit, division or department. While it could be observed that waqf is placed at a higher position in the hierarchy, it still trapped in a multi-layer decision making process that make it less efficient, time consuming, lengthy documentation and need for endorsement for many matters in hand (Marzuki & Ramli, 2018).

Despite of the empowerment and authority as religion administrative body, majority of SIRCs cannot escape from facing the administration issues, especially on the human resource. It is quite common for the SIRCs to have imbalance and insufficient staff (Saadan & Abd. Halim, 2014; Abdul Majid & Said, 2014). It also contributed by the employment of staffs who are incompetent in land development due to different education background or knowledge expert (Mar Iman & Mohammad, 2014; Saadan & Abd. Halim, 2014; Abdul Majid & Said, 2014). The staffing issue has remained in the SIRCs for a very long time without conclusive solutions because it involved with the employment and designation control by the Public Service Department which subject to Article 112 of the Federal Constitution (Mohamed

Azmi, 2020). This has exposed some shortages in the current administration policies, especially when needed to deal with other development related agencies such as the land office, municipality office, town planning department and several other agencies (Mar Iman & Mohammad, 2014; Omar et al., 2014; Mohamad et al., 2012; Syed Abdul Kader & Md. Dahlan, 2017).

Financial and budgeting are also crucial to the SIRCs, where in many instances have hindered the development of waqf land (Mar Iman & Mohammad, 2014; Mohd Salleh & Ramli, 2018). Financial and budgeting have become part of the governing challenges for the SIRCs due to their limited budget, which resulted them to seek for external funding for waqf development projects. The setup as the statutory body, bureaucracies and different competencies of the staffs have made the SIRCs cannot easily involve in money market or commercial activities to generate more incomes. This would require the SIRCs to establish a subsidiary to conduct those activities or partnering with strategic partners.

There is an increased expectation from the public who want to see optimum potentials through the waqf development. Through various ways, the public has urged the SIRCs as the waqf sole trustee to employ the best administration practice. It is a huge challenge for the SIRCs to optimise the development efforts for waqf while maintaining their core functions relating to other Islamic religion affairs.

Obligations Challenges

Obligation is an action to follow the stipulated laws, rules, and regulations. For SIRCs, they are obliged to the shariah and civil laws. From the religion viewpoint, waqf must abide shariah laws and cannot differ from the Islamic scholars' opinions. Any proposal to develop waqf land needs to get the *fatwa* (Islamic legal verdict, juristic opinion) and clearance from the Fatwa Council who will examine the shariah concerns on the development intention (Mar Iman & Mohammad, 2014; Mat Rani et al., 2014; Abdul Majid & Said, 2014).

In relation to the land development process, there are situations where the SIRCs would have certain issues to meet with the provisions from several other laws due to conflict of shariah obligatory for waqf. For example, the intention and usage of the waqf might in contrary to the planning zoning because the donor had wished otherwise; or the SIRCs cannot surrender some portion of the waqf land to the local authority for provision of public amenities during the development because it will reduce the land size, which is not permissible in the shariah context. Getting involve in the conflicting rulings situation, the SIRCs at most of the time have to negotiate and find ways with the responsible agencies to allow the development to take place because shariah rulings must be principally followed (Omar & Md Yusof, 2014; Abdul Majid & Said, 2014). The outcomes from the negotiations were usually not consistent and different from case to case depending on how the negotiation took place and type of proposed development.

Laws are mostly rigid in their provisions and interpretations. This rigidness may sometimes hinder the development intention, but every ruling must hold its integrity to ensure its efficacy. Waqf is also rigid in its rulings, but in many instances, Islamic scholars are allowed for the process of ijtihad (independent reasoning process by Islamic scholars to find solutions) and introduce innovations in waqf for the benefits of people (Kamali, 2008, 2014).

Waqf allows for innovative ideas to suit with the contemporary needs of the society. However, the Fatwa Council still need to examine and determine the suitability of the idea, which to minimize the exposure of risks and safeguarding the interest of the waqf (Omar et al., 2014). The innovations and improvements will be difficult to be approved by the *Fatwa* Council if they are too far-reaching and risky. So, the intention of developing the waqf land must be realistic, serving the beneficiaries and not much contradictory to the normal practice.

RESEARCH METHOD

The objective of this study was to explore the governing structural challenges for the development of waqf land in Malaysia. The study is expected to identify key challenges related to governing structure that could influence the progress of waqf land development. The process to fulfil the objective of the study is presented in Figure 2.

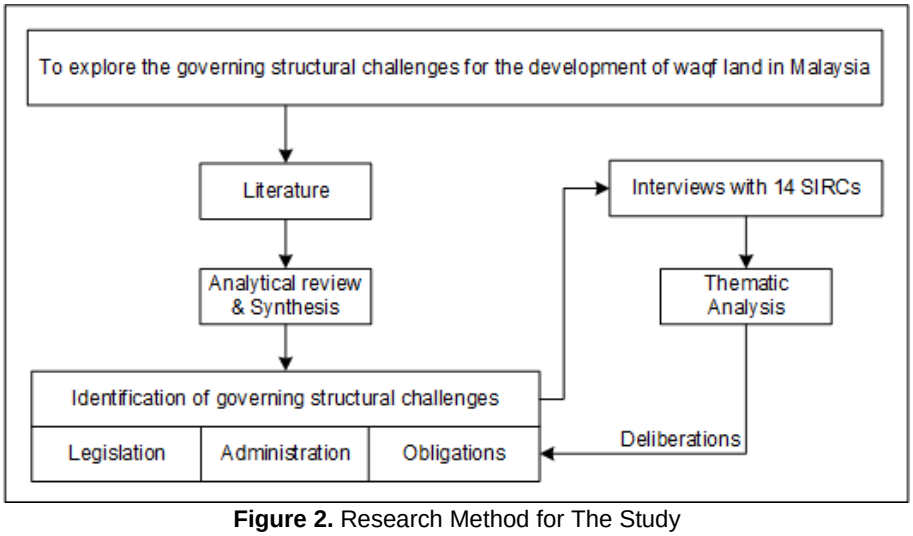


Figure 2. Research Method for The Study

This study was adopting the qualitative design which depended on the body of literature to do the exploration and had employed interviews as instrument for data collection. The study had gone through the analytical literature review and synthesis. The literature search was driven by the intention to explore the challenges related to waqf governing structure. The synthesis process was guided by the existing waqf development challenges. Then, all those challenges were filtered and sorted into categories before finally grouped into three emerging categories that become the challenges for waqf governing structure.

The study then decided to interview all of 14 SIRCs to confirm the identified waqf development challenges. These 14 SIRCs are accounted as the whole number of waqf sole trustees in Malaysia, thus did not require for sampling. Some background checking on the informants were conducted to ensure the reliability of the data sources. This study is confident that all the informants were sitting at strategic positions with vast experience and directly involve in waqf affairs in their states. This study had also sought their opinions on how to mitigate the existing structural challenges.

Findings from interviews were processed using the thematic analysis with the help of ATLAS.ti software. Deliberation was made to match the findings from the interviews and literature. The study was satisfied that the findings were consistent with the literature and not having difficulty to match with the identified three categories of governing structural challenges.

FINDINGS AND DISCUSSIONS

From the interviews, all informants were agreed that managing and developing the waqf land are challenging. There are so many contributing factors that make the SIRCs always struggle to face the challenges. But still, they would never fail to ensure that waqf interest are protected and flourish for the benefits of the ummah and society at large. The findings from the interviews are presented into three categories as follows.

Legislation

All SIRCs were agreed that the country's legislation system is quite rigid but prominent in regulating their functions. The regulating statutes and rules have determined their administration system and made them to be equal in the authority power. Only that, their internal policies and practices are different subject to the organisations' strategy in accommodating different local needs in the states. Furthermore, every SIRCs would have specific problems to handle and improvement ideas which coined by their Rulers, political figures, leaders and communities. This consequently led to differences and inconsistency of waqf development policies and bureaucracies between states.

Many informants were complaining that some provisions in certain statutes have superseded the authority of the SIRCs in managing and protecting the interest of waqf. Among the said provisions are found in the National Heritage Act 2005, the Local Government Act 1976, the Land Acquisition Act 1960, and the National Land Code 1965. For many times, the SIRCs must seek for the *fatwa* or decision from the *Fatwa* Council. Also, would try to negotiate or request for the responsible authorities to avoid the implementation of these laws on waqf or consider reducing the impact from the implementation. But, not always successful because these laws also need to uphold its integrity and equality. Apart from that, the hierarchy of judicial authority is also become an issue. As in the practice, the Shariah Court will handle cases or disputes related to waqf because waqf is a religious affair, but because of various reasons and judicature technicalities, many waqf cases were transferred to the civil court.

Administration

The administration challenges faced by the SIRCs were including the difficulty to get and keep charismatic leaders and personnel. Quite usually secondment officers from the Administration and Diplomatic Officer (PTD) scheme or other government organisations are placed into the SIRCs but will not be there for a long period. The informants were highlighting that they need for people who have visions and able to guide them through out the process until success. Other than that, the list of administration challenges continues with the improper staffing composition in the SIRCs, unfavourable human resource policies, internal bureaucracies because of multiple administration layers, rigid decision-making process due

to governmental administration policies, shortage of operational budget, difficulties to secure the waqf development financing, treatment by the State Government and relationship with the Federal agency. Undeniable that these challenges were lingering within the organisation and only a few involving the external parties.

Changing the system in the organisation will not be an easy process for any SIRCs although the management may introduce many improvement efforts through benchmarking, modernization, and upgrading. The root cause of the issue is coming from the employment and job designation within the SIRCs, which must be resolved at the policy maker level. Some informants highlighted that the SIRCs should have experts in various management areas, which including the land development or project management field within their organisation because although they are not listed as one of the technical agencies, but they possess a lot of real estates that demand for professional knowledge and skills.

Obligations

The findings also revealed that the SIRCs had faced difficulty to get the development project approvals from the local authority. It became worse when the SIRCs are lacking knowledgeable officers in handling the development application. For SIRCs, applying development approval is a daunting task because they must understand and meet various procedures and requirements as specified by local authorities. Quite regularly, the SIRCs cannot satisfy the local authority and must revise the development proposal before resubmitting it. The SIRCs must bear with the delay at the local authority approval process and revise the proposal accordingly to avoid problems in obtaining the Certificate of Completion and Compliances (CCC) for the building. The informants were also revealed that there were many developments such as the independent religious schools that operate on the waqf lands under the purview of SIRCs do not have the Certificate of Fitness for Occupancy (CFO) or CCC. Since the waqf land is under their purview, the SIRCs must take action to resolve the issue and ensuring the safety of the occupants although not involve in the operation of those schools. However, the rectification process is tricky where the SIRCs must bear the cost and face the consequences due to non-compliances.

Both the National and State *Fatwa* Council can issue the *fatwa* for the reference of the Muslims in Malaysia. But system in Malaysia only recognizes the State *Fatwa* Council to authorize the fatwa through the State Gazette and legally take effect. It becomes the reason of why certain *fatwas* between states are different or unavailable. So, the reference to *fatwa* about waqf and its development would need for careful scrutinization and must be applied individually to the State *Fatwa* Council. Each waqf development may require for different *fiqh* interpretations and justifications.

Mitigation Ideas

As part of the interviews, the informants were asked about the mitigation of the governing structural challenges. Besides that, the study had posed the concept of the establishment of a dedicated property development subsidiary known as the Special Property Development Entity (SPDE) to the informants and seek for their opinions whether the concept could partially mitigate the existing waqf governing structural challenges.

In dealing with many structural challenges, the informants had given mixed responses because the SIRCs were in tight conditions to manage waqf. This study was aware that they were preoccupied with the existing problems and daily routines in the office, which make them can only wish for the changes. Not to say that they were not trying, but they lack numbers to bring the changes to the whole system unless there is a top-down approach from higher authorities. Still, they have good visions on waqf and optimist that they can find ways to change the situation.

Regarding the concept of SPDE, most of the informants agreed that the SPDE concept is possible to be adopted because SIRCs do not have any restriction to own any subsidiary. In fact, the SIRCs already have the subsidiaries that involved in several commercial and non-commercial activities. The study believes that most of the SIRCs are aware about the success of Singapore Islamic Religious Council to implement the concept and change the landscape of their waqf sector. But the idea is stuck at the top management in the SIRCs and waiting for any SIRCs to show the evidence of success before replicating the concept.

About the legislation challenges, most informants did not sure how the SPDE can overcome those challenges. This study could understand that because the legislation system is very much rigid compared to others. But SPDE is quite agile and flexible to move with the existing regulatory provisions.

About the structural challenges related to administration, informants from Selangor and Penang were very positive about the establishment of SPDE. For them, SPDE is a private entity, which could be more flexible in its setup compared to the SIRCs, which able to have a better administration structure. A private setup like the SPDE can effectively overcome improper staffing composition, human resource policy, internal bureaucracy, and rigid decision-making process. The SPDE can have more authority to set its administration system without being trapped with the governmental establishment. Unlike the SIRCs, the SPDE would also have the liberty to generate incomes and secure the development financing for the waqf project using the instruments from the financial market. In addition, this study agreed with informant from Pahang who had mentioned that the SPDE will practice professional code of conduct in their business and consequently increase their professionalism.

On the obligations to the rules and *fatwa*, all informants were agreed that professional people would have better capability to handle waqf development and its approval processes. The SPDE could employ professional people in the organisation to produce better waqf development projects that suit to the rules and *fatwa*. The SPDE can strategise to oblige to any development rules and technical requirements while maintaining the obligation to match with the Shariah considerations as suggested by the *Fatwa* Council.

CONCLUSION

The structural challenges could influence the progress of waqf development. In general, the SIRCs would respond differently to those challenges. This paper has successfully identified the structural governing challenges for waqf land development in Malaysia and categorized them into three main challenges. The legislation challenges would be perceived as the most rigid and difficult for the SIRCs to mitigate. The administration challenges are possible to be handled by the SIRCs if they can have strategies and possess the enabler to

change certain administrative aspects. Meanwhile the obligation challenges are much depending on how the SIRCs able to understand and interpret the obligatory requirements set by both the shariah and civil laws. The solutions or mitigation approaches need to be formulated although might not be sufficient to tackle all the challenges. But at least, the SIRCs and any other waqf players would know and understand what they are dealing with. Weighing the available challenges, if not possible, this will take time to set everything ready and ideal for better progress of waqf development in this country.

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ASSESSING THE BARRIERS TO KNOWLEDGE SHARING PRACTICES IN CONSTRUCTION JOINT VENTURES THROUGH CASE STUDIES

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Abstract
Joint ventures often used by construction companies as a strategic platform to enable learning and gain knowledge associated with their partner skills and capabilities and integrate the new knowledge into own system and structure. While many benefits of joint ventures were highlighted in previous studies, it does not work well in reality since people are often uncertain to share their knowledge and experience. Moreover, the nature of construction projects and temporary setting of joint venture organisations often results in difficulty to retain the knowledge of each project member once the project completed. These problems become more critical in a foreign-local joint ventures where knowledge must be shared across different organisations with different national cultures. The aim of this research paper is to assess the barriers for knowledge sharing practices by using cross-case analysis of joint venture projects as case studies. A qualitative approach with a multiple-case study method was adopted to perform exploratory case studies into selected construction joint ventures in Malaysia. Qualitative data were collected from two case studies using the semi-structured interviews with 20 interviewees. Content analysis and cognitive mapping techniques were used to analysed the data. The research findings discovered several barriers to knowledge sharing practices within joint venture project settings such as the cultural barriers, lack of loyalty and project continuity, language barriers, unwilling to share and learn; and lack of time. As outlined in CIDB Construction Revolution 4.0 (CR4.0), the Malaysian construction industry is taking initiatives to improve its current project performance through capacity development by encouraging the collaboration between construction participants. It gives a very substantial explanation for undertaking this research concentrating on cultivating the collaboration and project performance of joint venture project settings through effective knowledge sharing.

Keywords: *Knowledge Sharing; Joint Ventures; Collaboration; Alliances; Culture.*

INTRODUCTION

Organizational performance can be enhanced by creating inter-organisation collaboration and alliances. As highlighted by Walker and Lloyd-Walker (2016), collaboration could increase efficiency and productivity, improve technical capabilities, increase competitiveness, reduce costs, share financial and organizational risks, and expand project value. Different organisations in a construction Joint Venture (JV) come together with their knowledge, expertise, and technical skills in order to commence and complete a construction project. Every organisation in a construction JV promotes its knowledge in the form of people, processes, and technologies, to the construction process (Khalfan and Maqsood, 2010). As purported by Khamaksorn, Joseph and Kurul (2020), the success of an organisation in today's competitive business environment is strongly related to its ability to utilise the knowledge and build its capacity.

There were circumstances in several developing countries when its contractors have lack of critical technical expertise and finance to undertake more complex, unique construction projects without help. This is very crucial especially for large scale and highly specialised construction projects. The main reason is the absence of managerial and technical abilities.

Therefore, the formation of construction JV is highly recommended mainly for pooling of resources, risks sharing, increase capability to undertake large and complicated projects, diversification of business activities and penetrate to a foreign market (Adnan and Morledge, 2003). Furthermore, local contractors are also resorting to JV amongst themselves as a strategy to enhance their capacity and capability in order to compete with foreign or international JVs (Kobayashi, Khairuddin, Ofori and Ogunlana, 2009). Each JV partner can learn from their collaborators through the shared implementation of the JV tasks, common understanding and problem solving, and also observations of JV activities and targets.

There are a number of different combinations of JV practiced in Malaysia such as JVs between Malaysian contractors and local partners; and also between Malaysian contractors and foreign partners. These JVs involve collaboration between two or more organisations working jointly to achieve certain objectives and each organisation contributes their knowledge and expertise together with other resources into the JV for the benefit of the construction project. Therefore, there is a need to have good management of knowledge within the JV organisation in order to help each JV partner to benefit from the collaboration.

Construction JVs have been identified as a medium for transferring of knowledge and technology between local and foreign companies that may be either project specific or of a long-term collaboration (Rowan, 2005). Knowledge sharing is an important element of any initiative for organisations and individuals to learn and develop. However, knowledge sharing is also a great challenge since it is well known that organisation members may be hesitant to share knowledge and information (Issa and Hadad, 2008), especially their vital knowledge, due to the pursuit of personal benefits. In the construction JV project settings where knowledge is shared between different companies with different organisational culture and national culture, it is essential to have good understanding of the best approach for successful knowledge sharing as well as the factors that influence its process. Hence, for knowledge sharing to be effective, it is important to understand its benefits and barriers.

RESEARCH PROBLEM

Nowadays, construction projects are increasing in size and complexity. To increase the capability and capacity of Malaysian contractors, the Malaysian government has introduced and implemented various initiatives to enhance the formation of a JV between local contractors and foreign partners especially in performing large infrastructure projects (Khairuddin, 2009; Mohd Damari et al., 2005). Working together requires sharing of ideas, information and knowledge which supports the successful implementation of complex construction projects.

JV is one example of inter-organisational collaborations that provide a good platform for the transfer and sharing of hard skills (technology) and soft skills (such as financing, management, experience, etc). JVs poses exclusive opportunity to combine the competencies and complementary resources of the participating partners, and this allows them to propose new products and services (Khamaksorn, Joseph and Kurul (2020). Yet, the reality does not work in practice as organisation members and project members may be hesitant to sharing their knowledge and experience, due to the search of individual benefit and potential cost involved such; as codification effort and loss of knowledge power (Huang, Davison and Gu, 2008). This situation often results in an enormous loss of important and valuable

organisational and project knowledge especially when employees retire or leave the organisation or project, resulting the knowledge created as less useful (Ma, Qi and Wang, 2008).

Numerous studies have specified that promoting knowledge sharing among employees can effectively appreciate knowledge and lead to the formation of new ideas. According to Serpell and Alvarez (2014), though many studies have examined the impact of intellectual capital on innovation performance, only few have considered the factor of knowledge sharing and analyzed the relationship among intellectual capital, knowledge sharing, and innovation performance of the construction industry. Thus, to enhance knowledge sharing within organisations, it is necessary to have clear understanding of the method of knowledge sharing as well as the factors influencing this process.

In most circumstances, knowledge created in a project is kept in the memory of various project team members. However, no one person retains a complete set of the knowledge generated. Hence, when the temporary organisation or the project team formed for a project is dissolved upon the completion of the project, the knowledge retained by each member is expected to be minimal. Most of the knowledge obtained from the project is unshared and is consequently lost. The competition among employees may also hinder the sharing of knowledge within an enterprise in the construction industry (Yongfu, Yu Song, Jinxin and Chengwei, 2019). It was found that there were limited studies on inter-organisational knowledge sharing i.e., between two or more organisations working on a JV project. Hence, it is significant to investigate how knowledge sharing happens in practice in a JV project organisation, by taking into consideration the JV project requirements and by looking into the barriers to the success of knowledge sharing.

The Malaysia Construction Industry Master Plan (CIMP) 2006-2015 and Construction Industry Transformation Programme 2016-2020 have also highlighted the importance of knowledge sharing that might help to improve the relationship and collaboration of the construction stakeholder. Several initiatives were carried out to improve the current project performance in Malaysian construction industry by encouraging the integration and collaboration of the construction participants by implementing more projects using JV approaches. These situations give a very significant justification for undertaking this research focusing on enhancing and improving the collaboration and project performance of JV project settings through effective knowledge sharing.

BARRIERS TO KNOWLEDGE SHARING

Previous studies, there are many barriers to effective sharing of knowledge and experiences in an organisation. According to Fong and Chu (2006), there were several main barriers to knowledge sharing mainly in Hong Kong contracting firms such as time constraints, the competitive working environment, reluctant in sharing best practice, and a lack of understanding of the benefits of knowledge sharing. Also, Mohamed et al. (2007) discovered several barriers to implementing knowledge sharing by construction organisations in Malaysia such as communication problems among employees, diversity of background between management and employees; lack of methods and tools; hoarding of knowledge; lack of support and commitment at management level; lack of understanding, and not enough time to share knowledge. Nadason, Saad, and Ahmi (2017) revealed that the organization's

strategic management tool is by having the relevant knowledge as well as can leverage and manage the knowledge.

Riege (2005) indicates that failure of knowledge sharing practices often due to organisations that try to adjust their organisational culture to fit their knowledge sharing goals and strategy, instead of the other way round. Mc Dermott and O'Dell (2001) highlighted that the main reason why most companies do not achieve their knowledge sharing goals is because of the lack of a clear connection between the knowledge management strategy and overall company goals. Most probably it was due to the lack of time for knowledge sharing and that it is recognized as a separate activity. It is important to understand the barriers to knowledge sharing at various levels within an organisation. Riege (2005) also suggests that barriers cover individual level, organisational level and technology level. Barriers at an individual level are often related to differences in national culture, over-emphasis of position statutes, poor communication skills and social networks, and lack of trust and time. Whereas barriers at an organisational level are more connected to lack of infrastructure and resources, economic feasibility, the accessibility of meeting spaces either formal or informal, and the physical environment. The barriers at the technology level, appear to be related with the unwillingness to utilize applications due to a mismatch of need requirements, unrealistic expectations of information technology systems, and difficulties in building, integrating and altering technology-based systems.

There have been several empirical studies that tried to provide some answers to the issues of barriers for knowledge sharing. However, much more empirical research needs to be done to address these issues more carefully to expand the value of knowledge sharing practices, through better understanding of ways in which to overcome knowledge sharing barriers.

RESEARCH METHODOLOGY

Case Study Strategy

Multiple case studies approach is used for this research due to the reason that the phenomenon to be investigated is not a critical test of a well-established theory, a unique circumstance, extreme, or has something special to reveal as purported by Yin (2014). In addition, the use of several case studies will enable the researcher to collect a large variety of information regarding the topic especially if the subject being studied is complex. Multiple case studies of JVs allow the researcher to understand the real situation of the interaction between JV partners and how knowledge is shared between them. This research used multiple-holistic case study since there is no logical subunits can be identified in the case study; and the relevant theory underlying the case study is holistic in nature as suggested by Yin (2014). The focus of this research was on wide-ranging issues such as the organisational culture, strategy, structure and motivation, etc.

Two (2) detailed case studies were involved in this research; utilising data consisting of knowledge sharing practices between local companies and foreign partners within JVs in Malaysia. Plus, it was conducted using replication logic; and not sampling logic. While replication logic is the overarching principle in case studies, they are also the unique characteristics in the way JVs shape the delivery of projects. It is to ensure that each case study can individually retained its context. A structured and standardised process for

collection and methods of analysis were employed for cross-case comparisons. In replication logic, standardisation between cases is very essential (Yin, 2014; Bryman and Bell, 2019).

Selection Criteria for the Case Studies

The selection of cases in this research follows a purposive sampling approach. The two cases selected consisted of construction projects that being undertaken through JVs in Malaysia. As a result of geographical limitation, the JV construction projects were selected in areas located near to the Klang Valley and this makes the practicalities of data collection easier. The projects were undertaken by JVs between local contractors and foreign partners. This criterion helps to obtain more impact on the knowledge sharing practices from the differences in national culture between the JV partners. Individually, each case has some unique characteristics (e.g., the organisational structure) and was at different stages of construction but both cases presented a holistic view of collaboration between local companies and foreign partners. The selection allowed the examination of knowledge sharing practices and their effect on collaboration throughout the period of the JV. Another factor limiting the study was to select a JV where the personnel at the top, middle and junior management levels are based in Malaysia for face-to-face interviews as the budget for data collection for this research did not cover trips to foreign countries.

In multiple-case study, the typical criteria regarding sample size are inappropriate because the number of cases goes beyond sampling logic (Yin, 2014). The choice should be based on the number of case replications that will present an appropriate level of certainty. Larger numbers are used when the external conditions will create different case study results. Table 1 shows the characteristics of the case studies for data collection and sampling.

Table 1. Characteristics of the Case Studies

	Case Study A	**Case Study B**
Type of project	Tunnel construction for inter-state water transfer.	Pumping station and the pipelines which involved earthwork and road works to an intake.
Joint Venture	JV between 2 Malaysian construction companies and 2 Japanese construction companies.	JV between 2 Malaysian construction companies and 1 Japanese construction company.
Semi-structured interviews		
- **Top-level mgmt.**	2 Locals and 1 Foreign	2 Locals and 1 Foreign
- **Middle-level mgmt.**	2 Locals and 2 Foreign	2 Locals and 1 Foreign
- **Lower-level mgmt.**	2 Locals and 1 Foreign	3 Locals and 1 Foreign
No. of Interviewees	10	10

Cross-case Analysis

As suggested by Yin (2014), the data for this study was analysed within the individual cases themselves (within-case analysis) and then across the two cases (cross-case analysis). Within-case analysis is carried out where the data from the interviews are compared with the literature review and this involves detailed writing-up for each case. Consequently, this will enhance the familiarity of each case as a separate unit. A unique pattern will appear from this process and this pattern can be generalised across cases (Amaratunga and Baldry, 2001). Subsequently, the cross-case analysis is carried out to compare the findings from both case

studies and identified the similarities and differences of each case. This is to ensure literal replication and theoretical replication will be established.

FINDINGS AND DISCUSSION

The cross-case analysis involved the identification and assessment of barriers to knowledge sharing from the data collected from the interviewees across various JV partners. The data were analysed using content analysis and cognitive mapping. As the findings, several barriers to knowledge sharing practices between JV project settings were identified. Table 2 summarised the findings from the cross-case analysis.

Table 2. Cross-Case Analysis of Barriers to Knowledge Sharing in Both Case Studies

Barriers Knowledge Sharing	Case Study A (CS-A)	Case Study B (CS-B)
Cultural barriers	- Different culture between Malaysian and Japanese companies in terms of employees' loyalty & dedication towards their parent companies. - Difference in project management approach and practices of the site operation e.g., site safety matters. - Differences in attitude towards time and discipline - Different level of expectation and justification on practicing certain standard	- Different working culture - Different level of standards in project management in relation to quality and safety aspects. - Different level of risk appetite or perception.
Lack of loyalty and project continuity	- Lack of project continuity in Malaysia compared to Japan. - Different approaches used by both local and foreign companies to retain employees (to ensure loyalty)	- Not applicable
Language barriers	- Minor language barriers- only a few Japanese project members had difficulty in communicating in English - Sometimes being misinterpreted - Slow communication and knowledge flow between two job sites located 100km away from each other.	- Japanese project members are not fluent in the English language hindering communication.
Unwilling to share and learn	- Individual attitudes towards learning and sharing knowledge - Fear of criticism - Fear of uncertainty	- Lack of willingness to share due to different scope of works.
Lack of time for knowledge sharing	- Not applicable	- Time constraints to share knowledge

Cultural Barriers

Both case studies highlighted issues related to cultural differences which act as barriers to knowledge sharing practices within their JVs. Nevertheless, the cultural differences identified are manageable because they are more related to differences in organisational culture compared to national culture. For example, both CS-A and CS-B stated that even though there are several differences in the project management approach, for example on quality and safety matters, the JV partners can still manage to follow or adapt with some modification and negotiation. The finding is consistent with the previous literature by Ozorhon et al. (2008) where it was specified that the differences in organisational culture between two international JV partners are controllable, because a company's organisational

culture can always be altered. As identified in CS-B, the JV partners had different perceptions of risk bearing on the project, where the Japanese partners are more likely to avoid risk than the Malaysian contractors. According to Chen, Zhiwei, Xuetong, and Yuming (2020) it is not easy to manage international joint ventures (IJVs) because the cultural differences among partners have a significant impact on alliance performance.

In relation to national cultural differences, both case studies suggested that the differences between the employees were related to the working culture such as attitudes towards time and discipline. It was found that the Japanese employees were more disciplined and good at time keeping. Somehow, this problem had an influence on the project performance especially in coping with the project deadlines on the work programmes. It can be seen that national culture influences the behaviour of an individual. Nevertheless, differences in national culture can be useful because it is a source of admiration and challenge, bringing to a higher level of communication and more lasting collaboration (Sirmon and Lane, 2004).

Language Barriers

From the cross-case analysis for both case studies, it was found that several project members faced language barriers; especially the Japanese junior staff. The Japanese contractor preferred using the Japanese language rather than English in their communications at the construction site, even in formal communication with the local partners. This has significantly impeded opportunities for sharing knowledge outside the formal channels. There were individuals that are highly fluent in both languages; however, these individuals do not act as full translators. For instance, within the JV organisation at the deputy project managers (DPMs) level in CS-A, the Japanese DPMs are fully bilingual, and will translate several information during meetings, but only enough to continue the conversation. However, due to the problem, both sides (Malaysian and Japanese) believed that they were unable to access all information and knowledge. JV parent companies from different countries often have different mother tongues, and this occasionally create communication difficulties. Misunderstandings that occur through translation or interpretation errors are among the most common problems for managers on foreign missions (Botha and Reynecke (2009). It is necessary to have effective communication between the parent companies to successfully carry out knowledge sharing. The required adaptation may be impossible to take place without effective communication and the JV will be unable to fulfil its mission, which may lead to termination. Apparently, on an individual basis, knowledge blocks normally happen due to language.

Lack of Time for Knowledge Sharing

Another barrier identified from the case studies was emphasised in CS-B; namely, lack of time for knowledge sharing especially during office hours. This is due to the fact that construction projects are activities which create different or unique products which require great amount of effort. In addition, one of the project objectives was to complete the project within the time stipulated, which makes project members feel constrained to work non-stop. The situation inhibits project members from having enough time to share their own knowledge. Time constraints are major reasons for lack of knowledge sharing in many organisations and projects. According to Skryme (2008), the more knowledgeable an employee is, the more their skills are required for the next task especially when there is

pressure on productivity and working to deadlines. Therefore, it is impossible to find the extra time to learn new knowledge or to have a session for knowledge sharing with colleagues.

However, an organisation should develop and use work templates which can allow people to work efficiently and to have extra time to take part in knowledge sharing activities. The term organisational slack can mean building non-chargeable time into peoples' work schedules, in which allowing people time to try using different solutions to solve a problem or by making sure that people with specialist knowledge are not fully committed to projects (Payne and Sheehan, 2004). Therefore, they have time to share knowledge and experience as problems arise throughout a project. It also can help experts to have adequate time to update their knowledge and encourage on lifelong education.

Lack of Loyalty and Project Continuity

Lack of employees' loyalty towards the parent company is considered to be one of the barriers to knowledge sharing especially in CS-A. Yet, this barrier was not identified in CS-B. Lack of employees' loyalty is normally due to poor working atmosphere and lack of clear rewards and recognition systems in the company. It is important to have clear rewards and recognition scheme in construction projects to motivates people to share more of their knowledge. Even though the effectiveness of both reward and recognition are still on deliberation, it is clear that the lack of these systems impairs the knowledge sharing effort of an organisation. In JV organisations such as in CS-A and CS-B, the temporary nature of the project and collaboration might affect the knowledge sharing effort by the project members. It is difficult to retain employees in a project of this nature. It was found that the Japanese partners highlighted that local (Malaysian) peoples tend to leave organisations or projects for a higher salary; or because there was a demand for their expertise.

In addition, lack of project continuity was also found to be a barrier to knowledge sharing on construction projects. There is lack of continuity within and between projects especially for JV projects, which involve different participants on each new project. Additionally, the uniqueness of individual projects in design and scope of works have given impact to the retention of the same project members. As claimed by Martinez (2016), in many cases, every new knowledge and experience gained from one project does not ensure that individual employees/personnel share that knowledge with others on the next project.

Unwilling to Share and Learn

Several interviewees from CS-A pointed out that there is unwillingness to share knowledge between the JV project members. The barrier is related to individual attitudes towards learning and sharing knowledge due to fear of criticism and uncertainty. This is strongly supported by previous studies which reveals that most people take pride in not seeking advice or sharing with others because they feel embarrassed to ask other people. They would rather discover new ways by themselves and for themselves. According to Hussin, et al. (2014), people are unlikely to share their knowledge without great individual motivation. There are internal and external motivational factors that impact knowledge sharing between individuals. The perceived power attached to knowledge and the mutuality that results from sharing are mainly recognised as internal motivational factors. Razmerita, Kirchner & Nielsen (2016) highlighted that Individuals are affected regarding motivation, fear and trust which

hoarding them from sharing knowledge. On the other hand, external factors comprise the relationship with the recipient and rewards for sharing knowledge. Another reasons for unwillingness to share and learn is due to poor communication skills. Construction personnel tend to be in difficulty when they are asked to share or transfer what they know. Hence, poor communication skills create difficulty in sharing tacit knowledge particularly to disseminate the knowledge into written documents.

Project members might not realise how valuable their particular knowledge is to others. Some people may be reluctant to demonstrate their expertise because they want to avoid being bothered by others when they are busy with their own work. They do not want to spend time bringing other people up to speed if sharing results in little reward. Moreover, Gray (2001) specified that some individuals are paranoid or distrustful about being replaced if they share their unique knowledge.

CONCLUSION

The barriers to knowledge sharing in the context of JV project settings needed to be identified from literature review for JV project members to understand the reasons that inhibit successful knowledge sharing practices. The specific gap identified influenced the conducting of a detailed investigation to identify the barriers to knowledge sharing as perceived by JV project members in Malaysia. The cross-case analysis results discovered five (5) main barriers to knowledge sharing in construction JVs such as cultural barriers; lack of time; lack of loyalty and project continuity; language barriers; and unwillingness to share and learn. From the list of barriers identified, construction companies intending to enter into JVs could have better understanding on the factors that inhibit knowledge sharing and allow them to take the necessary actions to minimise or avoid those barriers for successful knowledge sharing within the JV.

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ASSESSMENT OF SAFETY MANAGEMENT PRACTICES AMONG MALAYSIAN CONSTRUCTION COMPANIES

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Abstract
This study aims to determine the level of Safety Management Practices (SMP) and identify the most critical dimensions of SMP among contractors operating in Sarawak, Malaysia. A descriptive research design and a quantitative research approach were used in this study. This research adopted a simple random sampling technique to obtain data from Grade 6 contracting firms registered with the Construction Industry Development Board (CIDB) in Sarawak, Malaysia. Out of the 118 distributed copies of questionnaire, only 42 were returned, yielding a response rate of 35.59%. This research used the 22.0 version of Statistical Package for Social Science (SPSS) software to analyze the data so as to perform descriptive analysis, factor analysis, and relative importance index (RII) to achieve the research objectives. The findings showed that the SMP level among the contractors operating in Sarawak, Malaysia is high (mean value: 4.39). The relative importance index (RII) revealed that the most critical dimensions of SMP were management commitment to safety (RII: 0.96) and the provision of personal protective equipment (RII: 0.96). This study contributes to the body of knowledge of SMP. This study is helpful to all stakeholders in the Malaysian construction industry by providing insight into the level and most important dimensions of the SMP of contractors operating in Sarawak.

Keywords: *Malaysia; safety; safety management; safety management practices; Sarawak.*

INTRODUCTION

The constant usage of heavy equipment at high levels by the construction industry has increased its exposure to safety-related issues (Ayob, Shaari, Zaki, and Munaaim, 2018). The issue of accidents in the construction industry is not confined to Malaysia alone but cuts across the globe. According to the Hong Kong Labour Department (2019), the Hong Kong construction industry recorded the highest number of accidents (31.7/1000 workers) in 2018, with the highest types of accidents (78.6%) being falling from a high level. Similar accidents were reported across the United States of America, Singapore, Norway, and Korea (Evanoff et al., 2016; Goh and Goh, 2016; Kang and Ryu, 2019; Winge and Albrechtsen, 2018). Similarly, 52.18% of construction accidents also include falling from a high level in China's construction industry (Zhou, Shen, Xu, and Zhou, 2018).

This study is motivated by the research gap identified in the literature. Recently, Wang and Cheng (2021) provided a direction for future research, which consist of five (5) areas of safety management. They are assessment of safety management indicators, emerging information technologies, stakeholders' collaboration in safety management, safety behavior and perceptions in the construction industry, and safety climate. These five (5) areas for future research identified by Wang and Cheng (2021) present research gap in the field of safety management. Out of the five (5) research gaps, two (2) are relevant to the current study, namely assessment of safety management indicators and safety climate. The research gap on safety climate relates to the first objective of this study. While research gap on assessment of safety management indicators relates to the second objective, safety climate reflects the collective perceptions of the policies, procedures, and practices shared among employees that

relate to their safety in the workplace (Luo, 2020). Assessment of safety management indicators related gap focuses on the discrepancies in conceptualizing safety management in terms of the number of safety management dimensions (Wang and Cheng, 2021). Therefore, the current study seeks to narrow down its focus to the area of safety climate and safety management indicators.

While there are myriads of literature on safety management, few of the studies have focused on safety management practices in Malaysia, particularly in peripheral areas such as Sarawak. Most studies on safety management emphasize the relationship between two or more safety-related constructs. Despite the importance of safety management practices (SMP) in construction firms, few studies have specifically focused on determining the extent of SMP. Consequently, there is less interest in safety management practice studies in the peripheral areas of Malaysia, such as Sarawak. Among the Few studies on SMP in other countries are the following: Cheng, Ryan, and Kelly (2012) in Hong Kong; Choe, Seo, and Kang (2020) in South Korea; GAO, Fan, Wang, Li, and Peii (2019) in China; Marín, Lipscomb, Cifuentes, and Punnett (2017) in Colombia; and Vinodkumar and Bhasi (2010) in India. Recently, Kerry, Abas, Affandi, and Amin (2021) studied the stakeholder's perceptions of the significant factors affecting safety management implementation at construction sites in Johor Bahru. The findings suggest that stakeholders have similar perception of occupational safety and health-related risk. While the study by Kerry et al. (2021) was conducted in Johor Bahru, it differs from the current research in terms of objective.

The present study aims to bridge this knowledge gap by determining the level of SMP. This study also seeks to identify the most critical dimensions of the SMP among contractors operating in Sarawak, Malaysia. The findings of this study will be significant to safety supervisors, project managers, and policymakers in light of the escalation of health and safety threats faced by construction site workers. Specifically, the findings will provide a valuable guide to those responsible for on-site safety in planning, managing, and overseeing safety compliance among construction workforces.

LITERATURE REVIEW

Safety Management Practices in Construction Industry

In this study, safety management practices (SMP) refer to safety policies, procedures, initiatives, activities, guidelines, structures that companies implement to prevent all forms of accidents, injuries, and hazards that could affect workers or employees (Marin, Lipscomb, Cifuentes, and Punnett, 2017). In this study, the term safety practices refer to the continuous implementation of all safety-related activities intended to enhance safety and prevent accidents at construction sites. Other aspects of SMP include providing safety training, conducting safety inspections, conducting safety meetings, and providing personal protective equipment. Safety training refers to the actual activity of construction workers in all aspects of safety. Nevertheless, safety inspection refers to the periodic conduct of safety inspections across the entire construction site. In contrast, safety meetings refer to the collective discussion of all safety-related matters among construction site workers (Cheng et al., 2012; Cheng et al., 2015). Finally, providing personal protective equipment (PPE) in this paper refers to providing all required safety equipment by the management, providing guidance on how to use them, and its optimum use by the workers (Keng and Razak, 2014).

There are various benefits for construction firms that implement the SMP. The benefits can be categorized as financial or non-financial. A construction firm that pays considerable attention to the SMP is likely to have zero or fewer accidents. Such construction firms will not waste time and money on safety-related compensation and legal matters. In terms of reputation, the construction firm can be identified as a safety-oriented firm. This recognition can attract more projects to the construction firm (Onubi, Yusof, Hassan, and Bahdad, 2021). A construction firm liable for inadequate SMP matters can have its certificate withdrawn or its construction site closed.

Consequently, the reputation of such construction sites can be at stake (Econie and Dougherty, 2019; Onubi, Yusof, and Hassan, 2019; Yiu, Chan, Shan, and Sze, 2019). From the perspective of innovation adoption, a construction firm that practices safety management as an innovation essentially enhances its financial performance. Studies have shown that adopting innovation (SMP) leads to better economic performance (Yusof, Marisa, and Kong Seng, 2020). An explanation for this is that an accident-free construction firm will have a good reputation and image. Therefore, a reputable construction firm will always be in a better position to be awarded a project.

There are inconsistencies in the conceptualization and number of dimensions of the SMP (Cheng et al., 2012; Gao et al., 2019; Vinodkumar and Bhasi, 2010; Lu, Taksa, and Jia, 2020). Hence, there is no agreement on the precise number of dimensions of the SMP. For example, while Lu et al. (2020) conceptualized SMP into three dimensions, Gao et al. (2019) and Vinodkumar and Bhasi (2010) identified six dimensions. On the other hand, Cheng et al. (2015) identified fifteen dimensions. As a result of the inconsistencies, this study has conceptualized the SMP into ten dimensions. The dimensions include appointing safety and health officers, providing personal protective equipment (PPE), promoting safety, management commitment to safety, safety communication, conducting safety inspections, providing safety policies, providing safety training, conducting safety meetings, and acquiring safety knowledge. The following are the ten dimensions of the conceptualized SMP in this study.

Appointing Safety and Health Officer

In this study, safety and health officers are competent, experienced, and knowledgeable persons appointed to provide safe workplace for construction sites. The officer is also responsible for planning safety control programmes for identifying potential hazards and providing professional advice on safety improvement and accident prevention. The Occupational Safety and Health Act 1994 (OSHA 1994) requires contractors to appoint competent safety and health officers to oversee safety matters at the construction site (Jørgensen, 2011).

The appointment of safety and health officers to oversee all safety-related issues at construction sites is well discussed in the literature. Likewise, literature has thoroughly addressed the importance of appointing safety and health officers to oversee safety-related matters at the construction site. However, despite the importance and role of safety and health officers, scholars seldom discuss it as a dimension of the SMP. Hence, this study strongly argues and considers the appointment of safety and health officers as a dimension of SMP. Safety and health officers play crucial role in implementing safety management (Jørgensen, 2011; Tong, Rasiah, Tong, and Lai, 2015; Wright, Hollohan, Pozniak, and Ruehlen, 2019).

Providing Personal Protective Equipment (PPE)

In this study, personal protective equipment (PPE) refers to any related equipment, tools, or related apparel that construction workers put on to reduce exposure or contact from any potential dangers, injuries, or death (Alemu, Yitayew, Azazeh, and Kebede, 2020). Scholars have unanimously agreed that the use of PPE during construction activities is essential for effective safety practices at construction sites (Alarcón, Acuña, Diethelm, and Pellicer, 2016; Shinde, Sadare, and Potdar, 2016; Kakaei et al., 2014). Furthermore, according to Spellman (2020), PPE at construction sites requires complete compliance, as specified in the Occupational Safety and Health Act (OSHA).

PPE has not been considered a dimension of SMP in most studies despite its importance in reducing fatalities and injuries at the construction site. Azhar and Choudhry (2015) and Wong, Man, and Chan (2021) are among the very few studies that considered provision of PPE as a dimension of the SMP. In the same line of thought with Azhar and Choudhry (2015) and Wong et al. (2021), this paper strongly considers the provision of PPE as a dimension of the SMP. The provision of PPE as a practice is a demonstration of management commitment to safety and reflects the implementation of safety management (Alarcón et al., 2016).

Promoting Safety

Keng and Razak (2014) and Cheng et al. (2015) examined the promoting of safety as a dimension of SMP and operationalized it into safety signs and safety warning signs. Safety signs are an aspect of safety promotion. In this study, safety promotion is an act of communicating safety-related information, such as danger zones. In the construction industry, safety signs are an aspect of SMP that indicates caution, danger, and warning. It is a common practice to use signboards, illuminated signs, graphic symbols, and various shapes to demonstrate safety-related colors (red, yellow, white, and orange) as a means of communicating safety (Keng and Razak; Bian, Fu, and Jin, 2020; Gao, Wu, and Luo, 2021; Mostly, 2015). The benefit of providing safety signs is to enhance safety awareness at the construction site because it is one of the shortest means of communicating safety (Nnaji and Karakhan, 2020). In addition, safety signs continuously remind workers about safety requirements at construction sites (Mosly, 2015).

Management Commitment to Safety

Commitment to safety is said to be in place when management is deeply involved and participates in all safety matters and programmes at all levels of the organization (Hassan, Subramaniam, Zain, Ramalu, and Shamsudin, 2020). Management commitment to safety has received considerable attention among scholars (Levovnik and Gerbec, 2020) because of its importance and influence on safety behavior and attitudes of workers in workplaces and construction sites (Brunetto et al., 2016; Flin, 2017; Kapp and Han, 2017; Lin, Lin, and Lou, 2017; Subramaniam, Shamsudin, Zin, Ramalu, and Hassan, 2016; Trinchero, Farr-Wharton, and Brunetto, 2017). The management can demonstrate safety commitment at two management levels. First, at the top management and second, in the middle management. Top management is responsible for formulating a safety-related policy for organizations (Vinodkumar and Bhasi, 2010; Hassan et al., 2020). The term "management commitment" is usually used as a dimension of SMP in the literature (Lu et al., 2020; Gao et al., 2019; Zulkifle

and Wan Hanafi, 2018; Jaafar et al., 2017; Marín et al., 2017; Subramaniam et al., 2016b; Subramaniam, 2016c; Cheng et al., 2015; Cheng et al., 2012; Vinodkumar and Bhasi, 2010; Ali et al., 2009; Mearns et al., 2003). For clarity, this study prefers to use "management commitment to safety". Hence, in this paper "management commitment to safety" refers to management commitment commonly used in the literature.

Safety Communication

This study defines safety communication as a process of information exchange between two or more individuals. For example, information exchange in a construction site can be between a safety officer and construction workers. However, communication can also be exchanged between management and project managers, safety officers, and supervisors. Safety communication must be open, simple, and clear enough to be understood. In addition, safety communication should focus on safety-related matters (Rashid, Nordin, and Salleh, 2014; Vecchio-Sadus, 2007). For example, a construction firm can implement safety communication by reminding construction workers through personal contact or periodic meetings to obtain feedback and suggestions.

Conducting Safety Inspection

In this study, safety inspection refers to a formalized or structured process for identifying potential hazards or accidents at construction sites. The safety officer should conduct safety inspections regularly or at intervals, for example, at the end of every week (Cheng et al., 2015). A safety inspector is required to compare the findings with the necessary safety standards. If there are any discrepancies or deficiencies, a safety inspector is required to take corrective action immediately. One of the benefits of safety inspection is the improvement of safety performance at the construction site (Zhang, Chi, Yang, Nepal, and Moon, 2016). The safety officer can conduct safety inspection physically by walking around to identify potential hazards or errors in safety implementation. Hinze (1997) suggests that safety inspections be performed or carried out without informing or communicating with workers. This practice will perhaps keep them committed to safety rules and regulations.

Providing Safety Policy

According to Raliile and Haupt (2020), safety policy involves safe working conditions and environment needed for the safety of both management and employees. Safety policy helps to provide all safety-related information that is known to all employees in organizations. It also helps in achieving safety awareness and the well-being of all employees at various workplaces and construction sites. A safety policy is required to guide safety implementation to accomplish the safety vision and mission goal. Safety policy refers to a written statement covering the principles and objectives of an organization as far as safety is concerned (Keng and Razak, 2014; Kin and Bonaventura, 2006). For example, a construction firm should implement safety policy by having a published statement reflecting its vision and mission in matters relating to the health and safety of all employees and construction workers (Kin and Bonaventura, 2006; Bakri, Zin, Misnan, and Mohammed, 2006; Griffin and Howarth, 2001).

Providing Safety Training

Safety training is a formal process for educating workers about safety knowledge, safety importance, and safety requirements for workers. It aims to enhance the understanding of safety among workers so as to eliminate ignorance about safety. In addition, safety training seeks to develop a positive attitude towards all safety aspects at the construction site. It also aims to enhance workers' commitment towards safety by updating their knowledge (Mazlan, Osman, and Saud, 2019; Demirkesen and Arditi, 2015). Studies on safety have shown that safety training increases safety awareness, promotes safety behavior, and encourages safety culture at the workplace and construction sites (Mazlan et al., 2019; Ricci, Chiesi, Bisio, Panari, and Pelosi, 2016; Robson et al., 2012).

Conducting Safety Meeting

According to Alvarez (2002), safety meetings are a medium whereby employees are reminded of their safety compliance obligations and abide by safety rules and regulations. Safety meetings are usually conducted to discuss and plan the implementation of safety policies at various workplaces and construction sites. In addition, it serves as a reminder to employees about safety matters. It can also serve as a medium for reviewing previous safety-related incidents and how to prevent similar incidents in the future (Karanikas, 2017). The safety committee plays a vital role in this regard. The functions of the safety committee include discussing the causes of accidents and prevention strategies. They also reviewed safety regulations, standards, and safety performance in order to evaluate the effectiveness of safety training (Bhagwati, 2006; Channing and Ridley, 2008).

Acquiring Safety Knowledge

This study defines safety knowledge as the acquisition of information and understanding of hazards, accidents, their causes, and the need to avoid the reasons that could result in accidents at the construction site. Adequate safety knowledge would enable construction workers to have better understanding of and identification of potential causes of accidents so as to avoid or prevent their occurrence (Dong, Wang, Li, Ding, and Luo, 2018). The need for and importance of safety knowledge among construction workers have been documented in the literature. According to Zhang and Fang (2013), assurance of learning can be achieved by obtaining continuous feedback from construction workers about the lessons learned and implemented. The safety knowledge equips construction workers to perceive, recognize, and prevent potential hazards and accidents. Table 1 presents the common dimensions found across previous safety management studies.

As shown in Table 1, seven (7) out of the ten (10) dimensions adopted in the current study are common across previous SMP studies. The seven (7) dimensions are promoting safety, management commitment to safety, safety communication, conducting safety inspections, providing safety policies, providing safety training, and conducting safety meetings. The remaining three (3) SMP dimensions are not commonly found in previous SMP studies. They are appointment of safety and health officers, provision of personal protective equipment (PPE), and acquiring of safety knowledge.

Table 1. Common Dimensions in Previous Safety Management Practices Studies

Authors	Safety Management Practices Dimensions	Dimensions adopted in the current study	Items present by authors in previous studies	Country	Common dimensions in previous studies
Wong et al. (2021)	1. Having a safety-offense points system 2. Conducting safety supervision 3. Providing safety training	- - Adopted	1. Providing safety training (5 items)	Hong Kong	1. Promoting safety, 2. Management commitment to safety 3. Safety communication 4. Conducting safety inspections 5. Providing safety policies 6. Providing safety training 7. Conducting safety meetings
Lu et al. (2020)	1. Management commitment to safety 2. Involving employee 3. Providing safety training	Adopted - Adopted	1. Management commitment to safety (7 items) 2. Providing safety training (4 items)	China	
Gao et al. (2019)	1. Management commitment to safety 2. Involving employees 3. Organizing responsibilities and procedures 4. Providing safety training 5. Inspecting and monitoring 6. Communicating and coordinating	Adopted - - Adopted - Adopted	1. Management commitment to safety (6 items) 2. Providing safety training (4 items) 3. Communicating and coordinating (7 items)	China	
Manu et al. (2018)	1. Having safety policy 2. Safety planning 3. Organizing for safety 4. Safety implementation 5. Measuring and Reviewing performance	Adopted - - - -	1. Having safety policy (2 items)	Cambodia, Vietnam, and Malaysia	
Zulkifle and Wan Hanafi (2018)	1. System of rewarding 2. Providing safety training 3. Management commitment to safety 4. Communication and obtaining feedback 5. Worker's participation	- Adopted Adopted Adopted -	1. Providing safety training (3 items) 2. Management commitment to safety (3 items) 3. Communication and obtaining feedback (3 items)	Johor, Malaysia	
Jaafar et al. (2017)	1. Management commitment to safety 2. Involving workers in safety 3. Providing safety training 4. Safety communication and obtaining feedback 5. Providing safety rules and procedures 6. Safety promotion policies	Adopted - Adopted Adopted - Adopted	1. Management commitment to safety (9 items) 2. Safety training (6 items) 3. Safety communication (5 items) 4. Safety promotions policies (5 items)	Klang Valley, Malaysia	
Marín et al. (2017)	1. Having worksite hazard profile 2. Management commitment to safety 3. Having safety system 4. Providing OSH Training	- Adopted - Adopted	1. Management commitment to safety – participation (7 items) 2. Providing OSH Training (8 items)	Colombia	
Subramaniam et al. (2016b)	1. Management commitment to safety 2. Providing training 3. Involving workers 4. Safety communication and obtaining feedback 5. Providing safety rules and procedures 6. Safety promotion policies	Adopted Adopted - Adopted - Adopted	1. Management commitment to safety (5 items) 2. Providing training 3. (3 items) 4. Safety communication (3 items) 5. Safety promotion policies (5 items)	The northern region of Peninsular Malaysia	
Subramaniam (2016c)	1. Management commitment to safety 2. Providing safety training 3. Involving workers	Adopted Adopted -	NIL	Malaysia	

Authors	Safety Management Practices Dimensions	Dimensions adopted in the current study	Items present by authors in previous studies	Country	Common dimensions in previous studies
	4. Safety communication and obtaining feedback	Adopted			
	5. Providing safety rules and procedures	-			
	6. Safety promotion policies	Adopted			
Azhar and Choudhry (2015)	1. Safety training	Adopted	1. Safety training (4 items)	Pakistan	
	2. Safety inspection	Adopted	2. Safety inspection		
	3. Safety promotion	Adopted	3. (2 items)		
	4. Providing personal protective equipment (PPE)	Adopted	4. Safety promotion 5. (3 items) 6. Providing personal protective equipment (PPE) (3 items)		
Cheng et al. (2015)	1. Written safety policy	Adopted	NIL	Hong Kong	
	2. Investigating and reporting an accident	-			
	3. Recording safety incidents	-			
	4. Having safety manual	-			
	5. Having and using a safety checklist	-			
	6. Accident statistical analysis	-			
	7. Having an organizational safety structure	-			
	8. Conducting safety inspection	Adopted			
	9. Providing safety training	Adopted			
	10. Safe work practices	-			
	11. Conducting safety meeting	Adopted			
	12. Conducting safety audit	-			
	13. Promoting safety	Adopted			
	14. Having a safety committee at the project/site level	Adopted			
	15. Having a safety committee at the firm level	Adopted			
Cheng et al. (2012)	1. Written safety policy	Adopted	NIL	Hong Kong	
	2. Investigating and reporting an accident	-			
	3. Recording safety incidents	-			
	4. Having safety manual	-			
	5. Having and using a safety checklist	-			
	6. Accident statistical analysis	-			
	7. Having an organizational safety structure	-			
	8. Conducting safety inspection	Adopted			
	9. Providing safety training	Adopted			
	10. Safe work practices	-			
	11. Conducting safety meeting	Adopted			
	12. Conducting safety audit	-			
	13. Promoting safety	Adopted			
	14. Having a safety committee at the project/site level	Adopted			

Authors	Safety Management Practices Dimensions	Dimensions adopted in the current study	Items present by authors in previous studies	Country	Common dimensions in previous studies
	15. Having a safety committee at the firm level	Adopted			
Vinodkumar and Bhasi (2010)	1. Management commitment to safety 2. Providing safety training 3. Involvement of workers 4. Safety communication and obtaining feedback 5. Providing safety rules and procedures 6. Safety promotion policies	Adopted Adopted - Adopted - Adopted	1. Management commitment to safety (9 items) 2. Providing safety training (6 items) 3. Safety communication and obtaining feedback (5 items) 4. Safety promotion policies (5 items)	Kerala, the southern part of India	
Ali et al. (2009)	1. Giving reward 2. Providing training 3. Management commitment to safety 4. Communication and obtaining feedback 5. Hiring practices 6. Employee participation	- Adopted Adopted Adopted - -	NIL	Malaysia	
Mearns et al. (2003)	1. Management commitment to safety 2. Worker's involvement 3. Health promotion 4. Health and safety policy 5. Organizing for safety and health 6. Health and safety auditing	Adopted - - Adopted - -	1. Management commitment to safety (6 items) 2. Safety policy (12 items)	United Kingdom	
Wright et al. (2019)	1. Appointing safety and health officers	Adopted	NIL	Canada	1. Appointing safety and health officers
Tong et al. (2015)	1. Appointing safety and health officers	Adopted	NIL	Melaka, Selangor, Shah Alam, Johor, Malaysia	
Jørgensen (2011)	1. Appointing safety and health officers	Adopted	NIL	Denmark	
Wong et al. (2021)	1. Providing personal protective equipment (PPE) 2. Safety training	Adopted Adopted	1. Providing personal protective equipment (PPE) (4 items) 2. Safety training (5 items)	Hong Kong	1. Providing personal protective equipment (PPE)
Alemu et al. (2020)	1. Providing personal protective equipment (PPE)	Adopted	NIL	Addis Ababa, Ethiopia	
Spellman (2020)	1. Providing personal protective equipment (PPE)	Adopted	NIL	-	
Dong et al. (2018)	1. Acquiring safety knowledge	Adopted	NIL	China	1. Acquiring safety knowledge
Zhang and Fang (2013)	1. Acquiring safety knowledge	Adopted	NIL	-	

Table 2 presents the sources and the number of items for each SMP dimension. There are ten (10) dimensions of SMP examined in this study. However, the items for seven (7) dimensions are commonly used to measure SMP dimensions. However, the items for appointing safety and health officers, conducting safety meetings, and acquiring safety knowledge were introduced in this study and justified based on relevant literature, as shown in Table 2.

Table 2. Number of Items for Safety Management Practices Dimensions

No.	Authors	Dimensions	No. of Items	Remarks
1	Wong et al. (2021); Azhar and Choudhry (2015)	Providing personal protective equipment (PPE),	3 items	Adopted
2	Azhar and Choudhry (2015)	Promoting safety	3 items	Adopted
3	Zulkifle & Wan Hanafi (2018)	Management commitment	3 items	Adopted
4	Subramaniam et al. (2016b)	Safety communication	3 items	Adopted
5	Marin et al. (2017)	Conducting safety inspections	3 items	Adopted
6	Subramaniam et al. (2016b) Zulkifle & Wan Hanafi (2018)	Providing safety training	3 items	Adopted
7	Vinodkumar & Bhasi (2010)	Providing safety policies	5 items	3 items are selected and adopted because they are commonly found in the literature
8	Wright et al. (2019) Tong et al. (2015) Jørgensen (2011)	Appointing safety and health officers	3 items	Items introduced based on literature
9	Cheng et al. (2012) Cheng et al. (2015)	Conducting safety meetings	3 items	Items introduced based on literature
10	Dong et al. (2018) Zhang and Fang (2013)	Acquiring safety knowledge	3 items	Items introduced based on literature

METHODOLOGY

Method

This study adopted a descriptive research design and a quantitative research method. A questionnaire survey was used to collect data from target respondents. A simple random sampling technique was used to select the sample for this study. The sample size for the present study was 118 from a population of 167 Grade 6 contractors registered with the CIDB in Sarawak. Hence, 118 copies of the questionnaire were distributed through electronic medium to Grade 6 contractors registered with the Construction Industry Development Board (CIDB), Malaysia. A total of 42 usable copies of the questionnaire were received, yielding a response rate of 35.59%. According to Cheung, Wong, and Yiu (2015); Dulaimi, Ling, Bajracharya (2003); and Akintoye (2000), the average response rate for the construction industry is between 20% and 30%. Hence, the response rate obtained in this study is considered adequate.

Based on Vagias's (2006) prescription, this study uses a 5-point Likert scale, with modifications on the measurement scale ranging from 1 to 5 as follows: 1 = "Not at all true", 2 = "Slightly true", 3 = "Moderately true", 4 = "Very true", and 5 = "Extremely true".

This research adopted the Slovin formula to calculate the sample size for this study. According to Yamane (1967), the Slovin formula is as follows:

$$n = \frac{N}{1 + N(e)^2} \quad (1)$$

Where, n = Sample size
N = Total population
e = Confidence level

Given, N = Grade 6 Contractor registered with CIDB
= 167 Total Population
e = Confidence level (90% to 95%)

The researchers used a 95% confidence level for better accuracy, which provided a margin error of 0.05.

Calculation,

$$\frac{n = 167}{(1+167(0.05)^2)}$$
$$= 118$$

Data Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS) Version 22. Descriptive analysis and relative importance index (RII) were performed to achieve the research objectives. Following Kamaruddeen, Sung, and Wahi (2020), the RII values for this study were obtained using Equation 1, which were used to determine the relative importance of the dimensions of the SMP among contractors operating in Sarawak, Malaysia.

$$\text{RII} = \frac{\sum W}{(A*N)} \quad (2)$$

Where;

w = weightage given to each factor by the respondent (Ranges starting from 1 – 5); where "1" is "Not at all true" and "5" is "Extremely true".

A = highest weight,

N = total number of respondents.

RESULT

Table 3 presents the demographic profile of the respondents. It shows the frequency in percentages of the positions, the level of education, the work experience, and the number of projects executed.

As shown in Table 3, the total percentages of site managers, project managers, safety and health officers, and other positions are 35.7 %, 23.8%, 11.9% and 28.6%, respectively. In addition, 52.4% of the respondents are degree holders compared to Diploma holders (38.1%) while 9.5% consists of master's degrees. In terms of work experience, most respondents have had more than five years of experience (26.2%). Lastly, 57.1 % of the respondents have executed not less than ten projects, 26.2% of them have executed 11 to 20 projects, 11.9% of them have executed 21 to 30 projects, and more than 30 projects have been executed by 4.8%.

Table 3. The Demographic Profile of the Respondents

Profile	Frequency	Percentage
Position		
Site Manager	15	35.7
Project Manager	10	23.8
Safety and Health Officer	5	11.9
Others	12	28.6
Level of Education		
Diploma	16	38.1
Degree	22	52.4
Master	4	9.5
Working experience		
Less than one year	5	11.9
One year to 2 years	9	21.4
Two years to 3 years	8	19.0
Three years to 5 years	9	21.4
More than five years	11	26.2
Number of projects executed		
Less than 10	24	57.1
11 to 20	11	26.2
21 to 30	5	11.9
More than 30	2	4.8

Validity and Reliability Test

Validity tests were conducted to validate the research instruments. Construct validity deals with the extent to which the construct item in the questionnaire measures what it is supposed to measure (Davis, Allen, and Cosenza, 1988). Construct validity was assessed from both the theoretical and statistical perspectives. This study obtained the variables in the instrument from previous studies that supported the validity of the theoretical construct.

The internal consistency of the scales was confirmed by checking Cronbach's alpha coefficients. Therefore, the cut-off points for measuring the reliability for this study was a coefficient alpha above 0.70, as recommended by Nunnally and Berntein (1994) and Nunnally (1978). Table 4 presents Cronbach's alpha coefficients for safety management practices' variables. All the variables in this study had values greater than 0.70.

Table 4. The Reliability Coefficient for Variables

	N of Item	Cronbach's Alpha
Appointing Safety and Health Officer	3	0.749
Providing personal protective equipment	3	0.782
Promoting safety	3	0.933
Management commitment to safety	3	0.863
Safety communication	3	0.721
Conducting safety inspection	3	0.758
Providing safety policy	3	0.733
Providing safety training	3	0.881
Conducting safety meeting	3	0.749
Acquiring safety knowledge	3	0.775

Descriptive Analysis

Validity descriptive analysis and RII were performed to achieve the first objective. All variables were measured using a five-point Likert scale. According to Hair, Black, Babin, Anderson, and Tatham (2006), mean values can be categorized into three (3) levels: low, moderate, and high. In this study, the categories are divided as follows:

Low : 1.00 to 2.33
Moderate : 2.34 to 3.33
High : 3.34 to 5.00

As shown in Table 5 and Figure 1, the mean values range from 3.75 to 4.81. This result indicates that the level of SMP among respondents is high. The mean values for each dimension of SMP are management commitment to safety (mean = 4.81, standard deviation = 0.35), followed by providing protective equipment (mean = 4.78, standard deviation = 0.35) and providing safety policy (mean = 4.45, standard deviation = 0.42). Nevertheless, respondents scored the lowest mean for safety training (mean = 3.75, standard deviation = 0.69). This result suggests that the respondents perceived a high level of agreement with the statements. The standard deviation values are also low, indicating a low disparity among the respondents (Sekaran and Bougie, 2016).

Table 5. Descriptive Analysis of the Variables

	Minimum	Maximum	Mean	SD	Level
Management commitment to safety (MCO)	4.00	5.00	4.81	0.35	High
Providing personal protective equipment (PPE)	4.00	5.00	4.78	0.35	High
Providing safety policy (SPO)	3.67	5.00	4.45	0.42	High
Acquiring safety knowledge (SKO)	3.67	5.00	4.44	0.47	High
Conducting safety inspection (SIO)	3.67	5.00	4.42	0.47	High
Appointing Safety and Health Officer (SHO)	3.67	5.00	4.40	0.44	High
Conducting safety meeting (SMO)	3.67	5.00	4.30	0.46	High
Safety communication (SCO)	3.67	5.00	4.29	0.47	High
Promoting safety (PSS)	3.67	5.00	4.25	0.48	High
Providing safety training (STO)	3.00	5.00	3.75	0.69	High

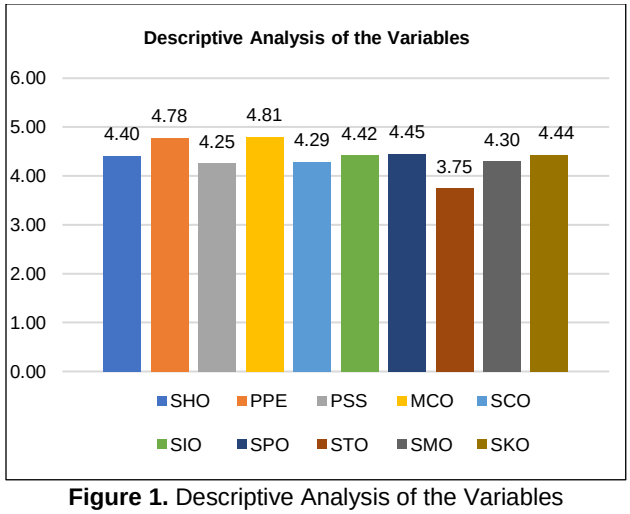

Figure 1. Descriptive Analysis of the Variables

Factor Analysis

The researcher performed the varimax rotation principal components analysis (PCA) to test the underlying dimensions of the SMP, as reported in the literature. Tabachnick and Fidell (2013) fully supported the PCA for factor extraction over explanatory factor analysis (EFA), especially for the empirical summary of the dataset. All factors for the variables in this study were considered in multidimensional ways. The purpose was to validate the scales and determine factor loading.

All items were subjected to PCA in order to determine their factor loadings. Tabachnick and Fidell (2013) suggest that a variable with a loading of 0.32 and above be considered a rule of thumb. Nevertheless, Comrey and Lee (1992) indicated that any loading that exceeds 0.71 is deemed to be excellent, 0.63 as "very good", 0.55 as "good", 0.45 as "fair", and 0.32 as "poor". A factor loading greater than 0.30 met the minimum value in the analysis while a loading of 0.40 was considered significant (Mokhlis and Salleh, 2009). However, following Marisa and Yusof (2020), a factor loading of 0.4 was considered the cut-off for an item to be retained. The principal component factor analysis with varimax rotation was performed on all the constructs of this study. However, Tabachnick and Fidell (2013) indicated that the cut-off point for the size of loading is a matter of the researcher's preference.

Another consideration for the factor analysis, as suggested by Tabachnick and Fidell (2013), is that the Kaiser-Meyer-Olkin (KMO) statistics should be a minimum of 0.6 (Kaiser, 1970; Kaiser and Rice, 1974). If this value falls below the minimum value, it is recommended that more data be collected or other variables are included (Field, Miles, and Field, 2012). Hutcheson and Sofroniou (1999) interpreted the KMO values as being between 0.5 and 0.7 as "mediocre", 0.7 and 0.8 as "good", values between 0.8 and 0.9 "are great", and values above 0.9 as "superb". The results of the factor analysis of all variables are presented in Table 6.

The results of the factor analysis show that the KMO value is "good" (KMO=0.741, Bartlett's test of sphericity = 1022.340, $p<0.01$). The total variance explained was 84.33 percent. Only factors with a loading value greater than 0.3 were considered (Mokhlis and Salleh, 2009; Marisa and Yusof, 2020). None of the items was deleted before anti-image analysis. Therefore, factor loading accepted all ten factors based on the original items. Table 6 presents the factor loading values for this scale.

Table 6. Factor Analysis of the Instruments

	Factor Loading									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Safety Communication (SCO)										
SCO1	.698									
SCO2	.790									
SCO3	.823									
Providing Safety Policy (SPO)										
SPO1		.610								
SPO2		.487								
SPO3		.855								
Promoting Safety (PSS)										
PSS1			.832							

	Factor Loading									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
PSS2			.938							
PSS3			.951							
Acquiring Safety Knowledge (SKO)										
SKO1				.555						
SKO2				.914						
SKO3				.866						
Management Commitment to Safety (MCO)										
MCO1					.839					
MCO2					.881					
MCO3					.943					
Providing Personal Protective Equipment (PPE)										
PPE1						.852				
PPE2						.859				
PPE3						.693				
Appointing Safety and Health Officer (SHO)										
SHO1							.884			
SHO2							.784			
SHO3							.636			
Conducting Safety Meeting (SMO)										
SMO1								.900		
SMO2								.817		
SMO3								.778		
Providing Safety Training (STO)										
STO1									.939	
STO2									.841	
STO3									.678	
Conducting Safety Inspection (SIO)										
SIO1										.854
SIO2										.427
SIO3										.654
Eigenvalue	4.881	4.199	3.935	2.710	2.548	2.032	1.445	1.385	1.267	1.067
Percentage	16.271	13.996	13.118	9.034	8.494	6.772	4.818	4.615	4.224	2.989
KMO	0.741									
BTOS	1022.340									
Sig.	0.000									

Relatives Importance Index (RII)

Following Kamaruddeen et al. (2020), RII analysis was performed on the ten dimensions of the SMP. The reason is that this study aimed to determine the level of importance of SMP. As shown in Table 7, the ranking of the dimensions of SMP according to their level of importance provides personal protective equipment (RII = 0.96), management commitment to safety (RII = 0.96), safety policy (RII = 0.89), and safety knowledge (RII = 0.89). This result was followed by conducting safety inspections and appointing safety and health officers (RII = 0.88), conducting safety meetings and safety communication (RII = 0.86), and promoting safety (RII = 0.85). Providing safety training (RII = 0.75) was ranked as having the least importance.

Table 7. Relatives Importance Index of SMP

	w	A	N	RII	Rank
Management commitment to safety	202.00	5.00	42	0.96	1
Providing personal protective equipment	200.67	5.00	42	0.96	1
Providing safety policy	187.00	5.00	42	0.89	2
Acquiring safety knowledge	186.33	5.00	42	0.89	2
Conducting safety inspection	185.67	5.00	42	0.88	3
Appointing safety and health officer	185.00	5.00	42	0.88	3
Conducting safety meeting	180.67	5.00	42	0.86	4
Safety communication	180.00	5.00	42	0.86	4
Promoting safety	178.67	5.00	42	0.85	5
Providing safety training	157.33	5.00	42	0.75	6

DISCUSSION

The objectives of this study are in two-fold. First, it seeks to determine SMP level. Second, it also seeks to identify the most critical dimensions of the SMP among contractors operating in Sarawak, Malaysia. Regarding the first objective, this study found that the SMP level among contractors in Sarawak is high. However, the International Policy and Research Development Division (2021) record states that approximately 207 occupational accidents in Sarawak occurred in July 2021. However, this study has found that not all the 207 recorded accidents are from the construction industry. Hence, the high level of SMP found among contractors in this study can be considered.

Regarding the second objective, the dimensions that are ranked first are management commitment to safety (mean value: 4.81; RII: 0.96) and the provision of personal protective equipment (mean value: 4.78; RII: 0.96). This finding is inconsistent with that of previous studies. For example, Gao et al. (2019) examined the mediating role of the SMP in the process safety culture of the Chinese oil industry. The results showed that management commitment to safety ranked fourth (mean value: 3.6). Similarly, Lu et al. (2020) examined the influence of management practices on safety performance in China's mining sector using a 7-point Likert scale. The results indicated that management commitment to safety was ranked third (mean value: 5.25). Vinodkumar and Bhasi (2010) examined the mediating role of safety knowledge and motivation on SMP and safety behavior in India. Their findings showed that management commitment to safety was ranked third (mean value: 3.37). The difference in management commitment to safety rankings between this study and previous studies could be due to regional factors. For example, the contractors in Sarawak perceived management commitment to safety as the most critical dimension, but this was not the case in previous related studies.

This study ranked safety policy second (mean value: 4.45; RII: 0.89). This finding differs from the findings of previous studies. For example, Cheng et al. (2012) explored the perceived influence of SMP on project performance in the Hong Kong construction industry. The findings showed that safety policy was ranked fourth (mean score: 3.69). Similarly, in Vinodkumar and Bhasi's (2010) study, safety policy was rated sixth (mean score: 3.17). The differences in the ranking of safety policies across studies show that respondents' perceptions differ from country to country. In other words, safety policy is ranked second in Malaysia, fourth in Hong Kong, and sixth in India.

In this study, safety inspection ranks third (mean value: 4.42; RII: 0.88). Thus, the findings of this study are consistent with those of previous studies. For example, safety inspection was ranked third in the survey conducted by Gao et al. (2019) in China (mean value 3.60). However, Cheng et al. (2012) showed that safety inspection was a critical dimension because it was ranked number one (mean value: 4.03). Hence, this study infers that the perception of safety inspection differs among respondents in China and Hong Kong.

The contractors operating in Sarawak perceived safety training provision to be less important than the other dimensions of the SMP. As a result, safety training was ranked sixth (mean value: 3.75; RII: 0.75). This finding differs from those of previous studies. For example, Vinodkumar and Bhasi (2010) and Lu et al. (2020) ranked safety training first. This finding reflects the high level of importance attached to safety training as a dimension of the SMP. Similarly, safety training was ranked second in the study by Cheng et al. (2012). This result indicates a common perception of safety training among China, Hong Kong, and India. The respondents in the current study ranked safety training sixth position possibly because the construction site workers' attitudes towards safety will still play a significant role in reducing accidents despite the safety training they have attended.

CONCLUSION

This study makes several contributions to the literature. First, it is beneficial for both scholars and practitioners. Second, it offers practical assistance to the implementation of SMP. This study complements the existing body of knowledge by providing a comprehensive definition of SMP in the construction industry context. This study also addresses the inconsistency in the number of SMP dimensions in the literature by conceptualizing the construct into ten dimensions. In addition, the findings on the level of importance of the ten dimensions of SMP can serve as a guide to safety officers and managers while managing safety at the construction site. Determining the level of SMP of contractors is beneficial to construction stakeholders, particularly regulatory agencies such as the Construction Industry Development Board (CIDB) and the Department of Occupational Safety and Health (DOSH). This study has shown that contractors in Sarawak demonstrate a high level of SMP. The study also has provided insight into the level of importance of the SMP dimensions. Next, this study has identified the top three most important dimensions of the SMP in construction. This finding could guide contractors, particularly safety officers, in the implementation of SMP. Concerning the practical contribution, this study provides insight into the status of the SMP of construction firms operating in Sarawak. The findings on the level of SMP will assist the government in safety-related policies.

As with other studies, this study has several limitations. First, the study focused only on the Grade 6 contractors operating in Sarawak. The scope of this study was limited to the G6 categories of contractors because they must employ safety officers to oversee safety matters at the construction site. In addition, Grade 6 contractors are more manageable in data collection during the movement control order (MCO) due to the Covid-19 pandemic. Future studies can focus on G7 contractors. Second, this study used a cross-sectional data collection approach. Because SMP is required throughout the construction phase, longitudinal data collection in future research can yield a better insight into the SMP of construction firms. Finally, identifying the impact of SMP dimensions on safety performance is beyond the scope of this study. Future studies should consider investigating such effects so as to improve safety performance at construction sites in Sarawak, Malaysia.

DISCLOSURE STATEMENT

The authors did not report any potential conflict of interest.

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RESIDENTIAL DEVELOPMENT OWNERSHIP AMONG YOUNG ADULTS IN KLANG VALLEY

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Abstract
Young adults refer to those between 25 and 40 years of age who had established themselves in the society. The increasing house price and interest rates has put homeownership among young adults are at risk. Most of young adults in Malaysia are opted to renting rather than owning the house. This research aims to assess the challenges faced by young adults in owning a house in Klang Valley. Klang Valley is chosen as study area because it is the center for development and economic of Malaysia, thus has been the focus of government policy and developer activities pertaining to housing. The survey was conducted with 385 respondents who stays and work in Klang Valley, by using simple random sampling. The data were collected and analyzed to have a better understanding on the challenges facing by young adults in owning a house in Klang Valley area. The study discovers that the most significant main factor influencing homeownership decision was location factors (*M= 3.79*), followed by Behavioral Factors (*M=3.46*) and lastly, Financial & Economic Factors (*M=3.22*).

Keywords: *Residential Ownership, young adults, Klang Valley.*

INTRODUCTION

Home or shelter is one of the necessities that contribute to our living besides food, water and clothing. Thus, a roof over one head's is one of a few requirements in life. Owning a house, is one of the major goals for Malaysians Teck. Hong (2008). It is everyone dream to buy or owning a place that we can called a home or house. Homeownership also can benefit not for only individual point of view but also affect to the communities in the surrounding. Teck Hong (2012) explained that a higher rate of homeownership creates motivation for homeowners to enhance the quality of their communities and develop homeowner's connection to their neighbours.

Purchasing house is a tough decision that we ever made in our life. Apart from that, most people will consider the option to buy the house is important thing that they need to be decide in their life. The decision making will depend on various internal and external factors. Like young adults' generation, this decision will arise once they are stating their career life, making a family, and aiming for a better quality of life. A study by Hartini, S. (2014) showed that the young generation in aged between 23 to 40 years old are now in the process of building their lives by having a permanent job, forming a family and living a quality life, thus good quality of life mostly associated with having a decent and appropriate house.

In nation such as China, Japan, Hong Kong and the UK, young adult were reported living in their parental homes and delaying their marriage since they couldn't afford to buy a property Yaacob, Mahazril Aini et al. (2018); Campos, B. C et al. (2016); Clapham, D., Mackie, et al. (2014); Deng, W. J., Hoekstra, J. S. C. M. et al. (2016); Izuhara, M. (2010); Izuhara, M. (2015); Li, R. Y. (2015); McKee, K., & Hoolachan, J. (2015). Young adults in Malaysia are also facing difficulties to own a house. This is due to the hefty property prices and the tightening of housing loans have made it difficult for young adults to buy their first home without any

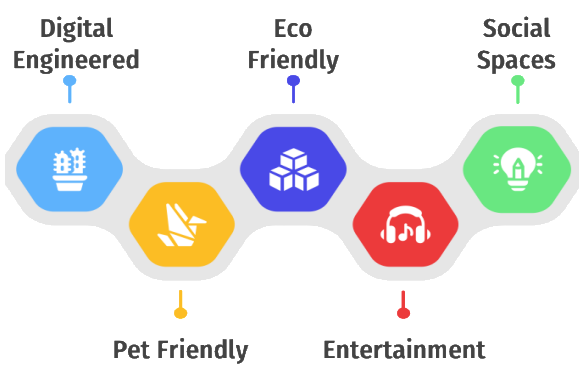
assistance from their parents (Zairul et al., 2015). Meanwhile, the National House Buyer Association (HBA) urge the intervention from the government to prevent a homeless generation of Malaysian young adult especially in the urban and sub-urban areas. The HBA stated that without the intervention of government to curb these issues, in future the young adult will not be able to buy their own houses.

As in 2018, young adult in Malaysia consists of 26% of population, it is approximately 8.4 million people. Therefore, it is important to assess the challenges for homeownership facing by this group. The increasing difficulties of purchasing a house among young adult are due to the internal and external factors. The aim of this research is to assess the challenges facing by young adults in homeownership by understanding their current status in the society.

LITERATURE REVIEW

Young Adult and Homeownership

The term "young" are referring to people who are aged from 15 to 24 years old according to the United Nation (2005). Whereas UNESCO does not indicate a specific age in defining the term, thus it views the term 'youth' as young generation who may leave obligatory education until they are hired for a first job. Meanwhile in Malaysia, The Youth Societies and Youth Development Act 2007 (Act 668), young adult is defined by individual which come from age of 15 until 40 years old. This young adult are usually referred as Generation Y or Millennials by different researchers.



(Source: The Edge Property, 2018)

Figure 1. Young Adult Housing Neighbourhood Criteria

In 2013, the TIME magazine labelled millennial or young adult as *"Me"* generation. This generation are notorious for their different interest, workplace behavior and fickle spending habits, thus are influenced by technology, education, and social media. The characteristic of these generation is unique as mentioned by Lachman, M.L., & Brett, D.L. (2013) Gen Y are self-indulgent, anti-authoritarian, and impatient.

Generation Y was born in the era of development of information technology and education world therefore they are concern about the aspect of work life balance as compared to other generation. The Edge Property article (2018) highlighted on the preferences of young adult on housing neighborhood criteria which are digital engineered, eco-friendly, social spaces, pet friendly and entertainment (refer to Figure 1).

Homeownership has a substantial effect on the inhabitants' physical and social well-being of the occupants and the economics features of the household finances (Hablemitoglu et al., 2010). Hence, homeownership has many advantages for individuals in term of better mental health and physical health, thus for communities such as social engagement and involvement (Xu, Y., Johnson et al., 2015). Consequently, homeownership has an important contribution to fulfil the necessary needs of human beings, this is by providing safety and security, which influence behaviour, prosperity and psychical wellness (Abidoye et al., 2021).

Factors That Influence Homeownership Decision

Location Factor

Location factors can be divided into urban dan suburban area, housing area located near to workplace, housing located near to public transportation or major highway, as well as new affordable housing located far from workplace or public transport. A study in the Unites States by Dawkins J. Casey (2009) found that first-time home buyer prefer to purchase a house outside the urban area, this is due to the factor affordability and high-cost of living in the city centre. Meanwhile, Bujang, A. A., Jiram, (2015) highlighted that the private developers are reluctant to build medium and low cost housing in the urban areas, not because there are no demand for those particular housing categories, but it is due to higher land cost in the urban area, thus building those houses are not given higher return to them.

Whereas, Oliver and Afiqah (2016) conducted a study among young adults in Malaysian urban areas indicates that young people preferred to purchase their future house in urban area, thus close to their workplace and surrounded with good amenities. This is supported by Dal. (2020) that found young adult in Turkey ranked the proximity to shopping centres and health institutions as important. These studies showed the importance of good accessibilities, amenities and facilities in the housing area as preferences for young adult to choose location for their residential.

Behavioural Factor

Individual behaviour is combination of reactions to internal and external stimuli. Individual behaviour defines how a person will respond under distinct conditions and will express different emotions such as happiness, rudeness, love, anger etc. It refers to some concrete action by an individual. Income levels and house prices are not the only determinants for young adults to access the homeownership. In fact, spending behavior among buyers is another determinant for affordability and ownership. Majid, Said, & Daud, (2014) assessed the extent of expenditures that influence housing affordability among young couples aged between 20 and 35 years living in the state of Selangor, Malaysia. A total of 215 responses were recorded using a nine-part questionnaire. They are monthly loan repayment, food and beverages, transportation, utilities, communication, household equipment, healthcare expenses and children's education, miscellaneous spending and saving.

Financial & Economic Factor

Economic & financial consideration is important factor that contribute to young household affordability to own a house. There is two side of affordability. On one side is income and access to financing, and the other is the price of the home. In this main attribute it will specifically focusing on income & access to financing or any other factor with exclusion of price of the home. Li, Ling Hin et al. (2017) conducted a study among young university graduates in Guangzhou found that the housing affordability is largely dependent on salary growth in the labour market, thus the study indicates housing affordability improves with work experience longevity and the corresponding salary increase. Meanwhile Abidoye et al. (2021) mentioned unaffordability and insufficient income were ranked as crucial barrier among young adults in Jakarta. The study suggested the government should control the housing prices and thus reducing mortgage interests as solution to these issues.

The Employee's Provident Fund statement in 2016 highlighted that 89% of the working population in Malaysia earn less than RM5,000 monthly, making home ownership especially challenging. Thus, the thought of dealing with a mortgage on the salary of a fresh graduate is making many young Malaysians think twice about owning a house. The uncertain income future posed a major limitation towards the ability to become homeowners as well the subjectivity of economic success. Even more, what draws attention is whether housing cost or household income is the problem of housing affordability.

Making the decision to buy a piece of property is a huge step that young locals are not quite brave enough to take yet. Monthly payment is considering a main spending when we commit to purchase a house by financing since the length of contract is between 30 to 35 years to be commit for the whole life. Because of this younger household income did not rise fast enough, many Malaysians resorted to bank borrowings to own their dream homes. This expansion in debt from 2009 to 2015 has made Malaysians households one of the most leveraged in Asia today. According to social news website SAYS which conduct 2019 Malaysian Home Survey among 8,568 Malaysians report that one in five respondents worries about making the wrong decisions, especially since homeownership requires a hefty financial investment.

Figure 2 highlight on the factors influence homeownership decision among young adults found from the literature review. All those highlighted factors are included the questionnaires and thus distributed to the young adults in Klang Valley area.

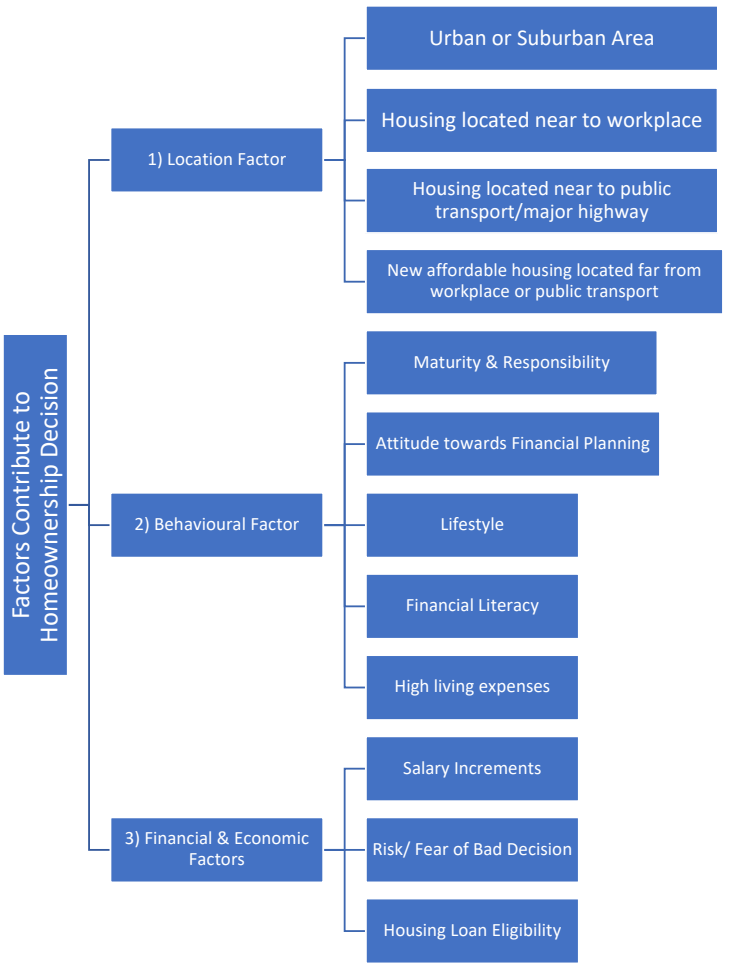


Figure 2. Factors That Influence Homeownership Decision Conceptual Model

RESEARCH METHODOLOGY

This section posits the methodology involved in assessing the homeownership challenges among young adults in the case study area. The respondents' characteristics, data collection techniques and analysis are also being discussed in this section.

Respondents

In this study, the respondents were derived from a population of young working adults in Klang Valley area. Since this study is still at the preliminary stage, only 400 questionnaires were distributed using simple random sampling, focuses on the young working adults from age 24 years until 35 years old who stay and work in Klang Valley. Specifically, researchers managed to obtain 385 numbers of returned questionnaire. The sample selected were in Klang Valley due to high urbanization in this area compared to other location. Therefore, the challenges are greater for young adults to purchase a property in this location due to high demand and other internal and external forces. Table 1 below refers to the respondents' characteristics in this study.

Table 1. Respondent Characteristics

Respondent's Profile	Criteria	Age (%)				Total (%)
		20 - 25 years old (10.91)	26 - 30 years old (69.61)	31 - 35 years old (17.4)	35 – 40 years old (2.08)	
Gender	Male	4.16	29.61	4.16	0.52	38.4
	Female	6.75	40.0	13.25	1.56	61.6
Education level	SPM	0	1.04	1.30	0	2.34
	Diploma	4.42	5.45	0.52	0	10.39
	Bachelor's degree	5.45	52.47	9.61	2.08	69.61
	Master's degree and above	1.04	7.53	5.97	0	14.54
	Others	0	3.12	0	0	3.12
Race	Malay	10.91	64.93	15.32	2.08	93.24
	Chinese	0	2.86	1.56	0	4.42
	Indian	0	0	0	0	0
	Bumiputra	0	1.82	0.52	0	2.34
	Others	0	0	0	0	0
Working Mode	Full time	8.83	67.01	16.62	2.08	94.54
	Part time	2.08	2.60	0.78	0	5.46
Type of Occupation	Public Sector	0	10.12	2.86	0	12.98
	Private Sector	9.35	48.31	14.55	2.08	74.29
	Self-Employed	0	9.35	0	0	9.35
	Not Working	1.56	1.82	0	0	3.38

Questionnaire Design and Analysis

The data for this research were collected using questionnaire that have been distributed to the young working adults in Klang Valley. The researcher did the arrangement of questionnaire, and the respondents must answer all the questions. Questionnaires were administered in various ways. For this research, questionnaire was distributed randomly to young working adults in various location within Klang Valley through direct interview approach, social media such as WhatsApp, Facebook and others. The respondents were chosen randomly, and in accordance with the range of age that qualified them as a young adult.

In this study, a self and structured questionnaire, adapted from several researchers was conducted. The questionnaire consists of two main sections; respondent's profile, and perception on homeownership, and factors contributed to the challenges of owning a property. Specifically, Section A highlights the demographics information sections. consists of the age, gender, educational level, race, working experience, working mode, resided location, working location, range of monthly salary, major financial commitment, monthly income saving, preferred type of house and preferred housing area.

As for Section B, it gathers the perception of the respondent, regarding the three (3) main factors that contributed to the homeownership variables, including Location, Individual Behavior, and Financial & Economic Consideration. The questionnaire uses a five-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5).

RESULTS

In this section, the data were presented via descriptive statistics including frequency, mean and standard deviation, through IBM SPSS Statistics version 27 software. Descriptive analysis is suitably used for this study, since it is a preliminary in nature, to explain certain nature and incidents. In addition, descriptive analysis is straightforward and easily understood by the reader (Jasimin & Ali, 2015). This section presents the results from the respondent's perception on the variables of homeownership, ranking of variables, and comparison from previous study.

Respondent's Perception on the Variables of Homeownership

In reference to Figure 3, 49.4% respondents agree that Urban or Suburban area location influence their homeownership intention, followed by 23.1% respondents that strongly agree with this variable. Despite, 20.3% view this variable as neutral in influencing homeownership. Secondly, majority of the respondents (84%) believe that housing location near workplace triggered their homeownership intention, against 5.2% respondents that were in a disagreement. Thirdly, 43.1% respondents perceived that housing should be located near public transport or major highway, while 32.2% respondents suggest they were neutral about this variable. Lastly, respondents largely in agreement that new affordable housing normally located far from workplace or public transport (74%). Figure 3 below shows the results of location variables perceived by the respondents.

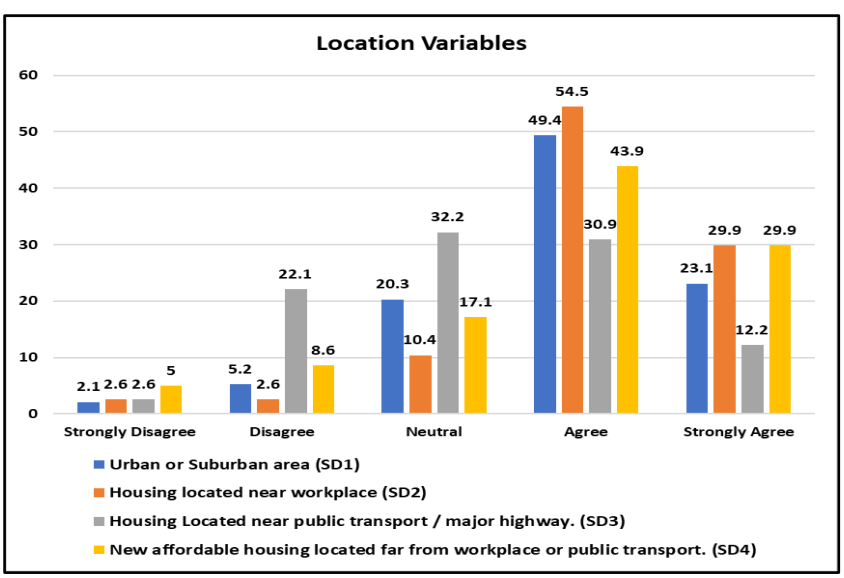


Figure 3. Respondent's Perception on Location Variables that Contribute to Homeownership Decision

In respect to the Behavioral variables, four variables were perceived by the respondents in reference to Table 2. Firstly, 49% respondents agree and strongly agree that maturity and responsibility impacted their decision towards homeownership, while a minority (19%) of the respondents suggest otherwise. Secondly, 55% respondents perceived that attitude towards financial planning, encourages their homeownership intention.

Thirdly, the results suggests that the respondents have a mixed response where 37% indicate neutral stance, while 37% shows they agree and strongly agree that change of Lifestyle influence their homeownership intention. Apart from that, majority of the respondents agree and strongly agree, financial literacy (84%) and high living cost/ expenses (83%) impacted their homeownership intention. Table 2 below shows the respondent's perception on behavioral factors that contribute to homeownership decision.

Table 2. Respondent's Perception on Behavioral Factors that Contribute to Homeownership Decision

Behavioral Factors	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
Maturity & Responsibility (IB1)	4.9	14.5	31.7	31.9	16.9
Attitude Towards Financial Planning (IB2)	17.1	37.9	20.8	17.1	7.0
Lifestyle (IB3)	9.6	16.1	36.9	28.3	9.1
Financial Literacy (IB4)	1.0	3.1	11.7	43.9	40.3
High Living Cost/ Expenses (IB5)	2.1	2.6	12.5	60.5	22.3

The respondents were also asked on the Financial and Economics Consideration variables including salary increment, risk/ fear of making bad decisions and housing loan eligibility. In reference to Figure 4, 60% of respondents perceived Salary increment, triggered their homeownership decision, while a small number of respondents disagree and strongly disagree (15%).

Secondly, most of the respondents (78%) believed that purchasing a house is a risky venture, therefore making a bad decision hinder their intention to homeownership. Surprisingly, housing loan eligibility was perceived to be least significant in homeownership decision by majority of respondents (65%), while 35% indicate a neutral stance. Figure 4 below, shows the respondent's perception on financial and economic factors that contribute to the homeownership decision.

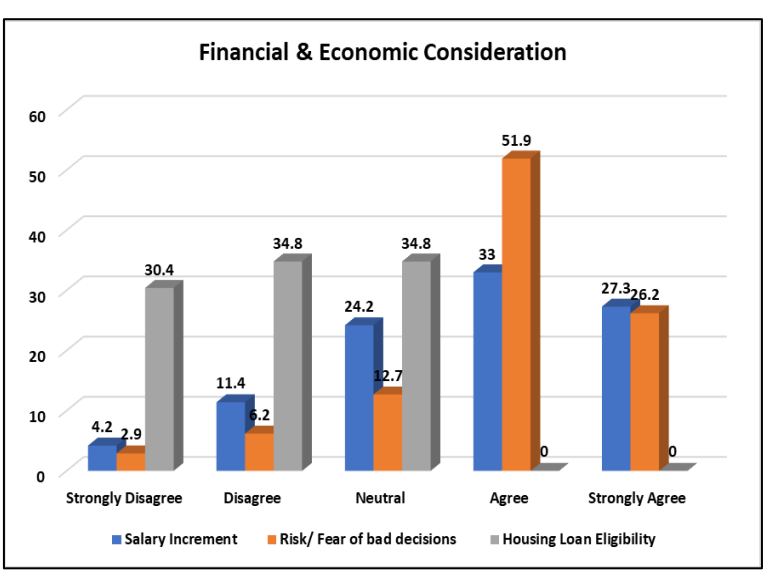


Figure 4. Respondent's Perception on financial and economic variables that contribute to homeownership decision

Ranking of Variables

Overall, mean analysis serves as a foundation to determine the ranking of most significant to least significant factors that influence the homeownership decision among respondents. Table 3 refer to the results obtained from the analysis of mean. Firstly, the findings suggest the most significant main variable was Location (*M = 3.79*) followed by Behavioral (*M = 3.46*) and Financial & Economic (*M = 3.22*).

Apart from that, the overall ranking suggests that the top five (5) variables significant in influencing the decision for homeownership were Financial Literacy (*M =4.19*), Housing location near to workplace (*M=4.06*), High living expenses (*M=3.98*), New affordable housing located far from workplace or public transport (*M = 3.94*) and Risk/ fear of bad decisions (*M = 3.92*). Followed by the factors of Urban or Suburban area (*M=3.86*), Salary Increment (*M=3.68*), Maturity & Responsibility (*M=3.41*) and Housing Located near public transport / major highway (*M=3.28*). The bottom three (3) least significant variables were Lifestyle (*M=3.11*), Attitude towards financial planning (*M=2.59*) and Housing Loan Eligibility (*M = 2.04*).

Table 3. Mean Results and Ranking for Homeownership Decision Variables

Main Factor	No.	Sub-factor	*N*	*M*	*SD*	Within Group Ranking	Overall Ranking	Main Factor Ranking
A. Location Factors	1.0	Urban or Suburban area (SD1)	385	3.8623	0.90096	3	6	1
	2.0	Housing located near workplace (SD2)	385	4.0649	0.85905	1	2	
	3.0	Housing Located near public transport / major highway. (SD3)	385	3.2805	1.02279	4	9	
	4.0	New affordable housing located far from workplace or public transport. (SD4)	385	3.9403	0.9265	2	4	
			Average	***3.787***				
B. Behavioral Factors	5.0	Maturity & Responsibility (IB1)	385	3.4130	1.08173	3	8	2
	6.0	Attitude Towards Financial Planning (IB2)	385	2.5896	1.16274	5	11	
	7.0	Lifestyle (IB3)	385	3.1117	1.08757	4	10	
	8.0	Financial Literacy (IB4)	385	4.1922	0.83818	1	1	
	9.0	High Living Expenses (IB5)	385	3.9844	0.80024	2	3	
			Average	***3.45818***				
C. Financial & Economic Factors	10.0	Salary (F1) Increment	385	3.6779	1.11578	2	7	3
	11.0	Risk/ Fear of bad decisions (F2)	385	3.9247	0.94485	1	5	
	12.0	Housing Loan Eligibility (F3)	385	2.0442	0.80727	3	12	
			Average	***3.2156***				

CONCLUSIONS

The study has identified the significant factors that contribute to the homeownership among young adults in the case study area. It tries to explore the behavior and psyche of this age group from the three (3) main factors including location, behavioral and financial. The preliminary findings are beneficial to the real estate developer as they can tailor their housing product in accordance with this age group preferences. Whilst the policy maker could aid in terms of introducing friendly policies towards young adult homeownership. Nonetheless, the study may not provide conclusive evidence yet, but it could serve as a preliminary reference towards understanding the young adult. Future studies can be expanded by incorporating other variables such as housing physical characteristics or employing different analysis technique such as the Partial Least Square Structural Equation Model (PLS-SEM) to model the relationship between variables of homeownership among young adults.

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RISK AND RETURN OF M-REITS DURING COVID-19: EVIDENCE FROM CAPITAL ASSET PRICING MODEL (CAPM)

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Abstract
COVID-19 pandemic has affected real estate sectors, including Real Estate Investment Trust (REIT), as the total return of a REIT is subject to the property market's performance. This research assesses the risk and return of Malaysian REITs (M-REITs) and All-REIT portfolios during the COVID-19 pandemic. Based on a desktop study, the researchers analysed M-REITs' historical monthly closing price, FBM KLCI and the yield of 10-year MGS using the Capital Asset Pricing Model (CAPM). The number of observations is 24, six (6) months before and 18 months after COVID-19 hits Malaysia. The result shows that the estimated return of M-REITs using CAPM ranged from -0.1905 to 0.2391. The researchers also develop an equally weighted portfolio where all 17 M-REITs have an equal weight allocation of 0.0588 to assess the fair estimated return of the All-REIT portfolio. The findings also suggest that despite the pandemic and implementation of Movement Control Order (MCO), the average monthly log-return of M-REITs outperformed the monthly log-return of the market portfolio in April and November of 2020 as well as March and June 2021. The remaining period recorded slightly at par with FBM KLCI. Beta at less than 0.1 also indicates that M-REITs is less volatile than the market portfolio. In conclusion, CAPM suggests that M-REITs show a low-performance deviation with market portfolio during the pandemic signifying that it is a low-risk investment and shall be included in any investment portfolios. The findings of this research are vital for investors in considering M-REITs for their investment portfolio.

Keywords: *M-REITs; All-REIT Portfolio; Risk and Return; CAPM; COVID-19; MCO.*

INTRODUCTION

COVID-19 have affected the norms worldwide, and various measures have been undertaken by the authorities to reduce the impact of the pandemic on the health, social and economic well-being. In Malaysia, the first COVID-19 cases have been recorded on January 25, 2020, increasing since then. The National Security Council of Malaysia has taken the step to implement the Movement Control Order (MCO) initiated on March 18, 2020, to curb the spread of the pandemic. To date, three MCO phases has been implemented nationwide namely MCO 1.0 (Mar 18, 2020 - Jan 12, 2021), MCO 2.0 (Jan 13, 2021 – May 11, 2021) and MCO 3.0 (May 12, 2021 – present). In addition to the implementation of this phased MCO at the national level, Enhanced MCO (EMCO), Conditional MCO (CMCO), Recovery MCO (RMCO) have been enforced at the different timeframes and states due to the differences of COVID-19 infection rate at each state.

The spread of this pandemic has affected the commercial sectors as many business operators are not permitted to open their business during MCO. Although there are several phases (CMCO and RMCO) in which traders are allowed to operate their business, the operation hours for some sectors have been shortened to reduce the risk of COVID-19 transmission. From the built environment perspective, this situation negatively impacts business activities such as acquisition, disposal, tenancy, lease, and other built environment-related investment linked to commercial spaces. Several researchers suggest that REIT data

can be used as a standard proxy for the commercial real estate market (Chong & Phillips, 2021). However, apart from the commercial sector, REITs also invest their capital in other sectors such as hospitality and equity. Several mechanisms on how pandemics affect REITs fundamentals have been highlighted, including rental collection, distribution requirement and leverage (Akinsomi, 2020). The explanation has been made on how COVID affects the utilisation of property space associated with REITs. In Malaysia, for instance, Pavilion REIT recorded a 57.23% declined in net property income for Q2 2020 from RM91.35 million in 2020 to RM39.07 million as revenue was impacted by rental rebates offered for tenant retention in the Movement Control Order (MCO) period (Shankar, 2020). The measures taken by Pavilion REIT have affected their rental collection while providing some relief for their tenants who were affected during MCO.

In terms of distribution requirement and leverage, a disruption in cash flow would affect the distribution of mandated dividend requirements of REITs because REITs pay out a significant amount of their earnings as distribution to qualify for tax exemption (Akinsomi, 2020). Realising this, Securities Commission Malaysia (SC) announced temporarily increasing the gearing limit for M-REITs from 50% to 60% from August 12, 2020, until December 31, 2022, to allow M-REIT managers to manage their REIT's debt and capital structures more efficiently (Securities Commission, 2020).

Overall, the findings obtained from similar studies differed according to the country, model and variables used. Therefore, this research aims to assess the estimated return of 17 M-REITs and the All-REIT Portfolio using CAPM. The next section elaborates the estimation of REITs return using CAPM.

THE APPLICATION OF CAPM IN ANALYSING REITs RETURN

REIT was firstly introduced in the United States in 1960 to provide a liquid way for investors to gain real estate exposure (Sha, Wang, Bu, & Mansley, 2020). Meanwhile, in 1986, Malaysia was the first Asian country to develop a REIT market based on the Australian Listed Property Trust Model and REITs in 2005 (Newell & Osmadi, 2009). The establishment of the REIT structure has brought a subsequent varying dynamic in the investment of capital into the built environment (Aveline-Dubach, 2016). It has been proven that the equally weighted M-REITs portfolio offer some diversification benefits for the mixed-asset portfolio (Lee & Ting, 2009). REITs are publicly traded like stocks which make REITs share some similarity of performance measurement tools (Example: CAPM, Arbitrage Pricing Theory, Fama-French 3 Factor Model, etc.) and methods of valuation with the stock market (Example: Net Asset Value, Discounted Cashflow, Dividend Discount Model, etc.). The most common asset pricing model used to compute the cost of equity capital of the firm is the CAPM developed by William Sharpe in 1964 (Coletta & Busato, 2020). Since its introduction, CAPM has been widely used to estimate assets' risk and return, including stock and REITs. The expected return of stock *i* (R_i) under CAPM can be described using the following simple linear equation;

$$R_i = R_f + \beta_i (R_m - R_f) \quad (1)$$

Where R_f is the yield on the one month Treasury bill (the risk-free rate), R_m is the return on the value-weighted market portfolio, and β_i is the CAPM risk factor of stock *the*, which

represents the slope in the regression of its excess return (over the risk-free rate) on the market's excess return (Coletta & Busato, 2020). The assumptions of the CAPM imply that investors should hold diversified portfolios where institutional managers make investment decisions based upon the investment marginal impact upon such a diversified portfolio, including REITs as real estate are always considered diversification vehicles (Below, Stansell & Coffin, 2000).

Beta is used as a measure of systematic risk under CAPM (Ong, The, Soh & Yan, 2012). In denoting the average of the firm-specific variances using CAPM, the portfolio risk becomes gradually smaller when the number of securities in the constructed portfolio increases while the systematic risk remains, regardless of the number of securities added into the portfolio (Coşkun, Selcuk-Kestel & Yilmaz, 2017). Therefore, it is vital to get accurate estimates of the company's betas. It will help managers evaluate investment projects by calculating an optimal hurdle rate, besides assisting analysts and investors in estimating the required return rate of a risky asset (Coletta & Busato, 2020).

However, the risk and return analysed are subject to several limitations as REITs invest in property or illiquid assets that are typically not actively traded. The market prices are not always readily available, resulting in their reported returns being smoother than actual (true) economic returns (Derwall, Huij, Brounen & Marquering, 2009) and other real estate-limitation features. In terms of efficiency of operation, the study of M-REITs in 2020 shows that several REIT sectors in Malaysia may be at risk of liquidity due to the declining of operating or current ratio from 2014 to 2018, as the current ratio of less than 1 is a red flag (Khairulanuwar & Chuweni, 2020).

Despite many advances and complex models to analyse risk and return of REITs such as Fama-French 3 Factor model, Factor Model under Arbitrage Pricing Theory and Dividend Growth Model, to name a few, CAPM still possesses its benefits of analysis. CAPM assumes that the investor holds a diversified portfolio, similar to a market portfolio and eliminates unsystematic risk from the diversified portfolio. In addition, CAPM is an outstanding tool for the ASEAN (Jamar, 2017) and emerging markets (Coşkun et al., 2017), which signifies its practicality in analysing the risk and return of M-REITs. Moreover, in terms of maturity of REIT, Malaysia is placed in an emerging category, implying the significance of M-REITs among other REIT regimes (Khairulanuwar & Chuweni, 2020) and was a pioneer in the Shariah-compliant or Islamic REITs in 2005 (Chuweni, Eves & Blake, 2017).

METHODOLOGY

Risk and Return of M-REITs using CAPM

In this research, the researchers employ a desktop study where the estimated risk and return of REIT have been determined using CAPM. Generally, CAPM has been used by recent researchers in estimating the risk and return of REITs (Sha, Wang, Bu, & Mansley, 2020). The first step is to analyse the estimated return of individual REIT followed by estimating the risk and return of the All-REIT portfolio. The estimation of M-REITs return using CAPM is as follow;

$$E(R_1) = r_f + [E(R_m) - r_f]\,\beta_1 \quad (2)$$

Where $E(R_1)$ is the estimated return of $REIT_1$, r_f = risk free rate, $E(R_m)$ is the estimated market return and β_1 beta for $REIT_1$**.** A market risk premium is included in the model via $E(R_m) - r_f$. This relation assumed that all REIT denoted in this model as "1" have the same ratios of reward, measured as the expected return in excess of the risk-free rate $E(R_1) - r_f$**,** to risk (β_1), which is consistent with the notion that investors trade-off returns and risk (Jagannathan & Wang, 1996). The equation also assumes that the risk-free rate is available and normally obtained from the long-term government bond yield.

Meanwhile, the estimated market return $E(R_m)$ in this model can be assess using population standard deviation (σ) with the inclusion of monthly log-returns of market portfolio $(Ln\ R_m)$ and number of observations at 24-months (N) as follow;

$$E(r_m) = \sqrt{\left(\frac{\sum(\text{Ln } R_m{}^2)}{N}\right) - \left(\frac{\sum(\text{Ln } R_m)}{N}\right)^2} \tag{3}$$

Beta (β) of REIT is calculated using the Market Model Regression (Slope). In this method, the researchers regress the REIT monthly log-returns against the estimated market returns $E(R_m)$. Linear regression in arriving at the beta is as follow:

$$E(R_1) = \alpha + \beta E(R_m) \tag{4}$$

Where $E(R_1)$ is the estimated return of $REIT_1$ **,** α is the intercept of regression, β: beta of REIT or slope in the Market Model Regression and $E(R_m)$ the estimated market return. The model can be rearranged by using inverse operations as $\alpha + \beta E(R_m) = E(R_1)$ and subsequently $\beta E(R_m) = \alpha$. The final arrangement of the slope in the model can be written as follow:

$$\beta = \frac{E(R_1) - \alpha}{E(R_m)} \tag{5}$$

Risk and Return of All-REIT Portfolio

Once CAPM of 17 REITs has been derived, the researchers calculate the portfolio return of the All-REIT Portfolio. Prior to that, researchers analyse the correlation coefficient of monthly log-returns of REIT to shed some insight on the viability of the portfolio to be established. In investment, a low correlation signifies that different asset types have not performed in the same way, allowing investors to take advantage of low Correlation in achieving portfolio optimisation (Stern, 2003). The correlation coefficient (ρ) based on the inputs of the CAPM used in this study are as follow;

$$\rho_{1,2} = \frac{N[\sum(\text{Ln } R_1)(\text{Ln } R_2) - (\sum \text{Ln } R_1)(\sum \text{Ln } R_2)]}{\sqrt{[N\sum \text{Ln } R_1{}^2 - (\sum \text{Ln } R_1)^2][N\sum \text{Ln } R_2{}^2 - (\sum \text{Ln } R_2)^2]}} \tag{6}$$

Where $\rho_{1,2}$ is the correlation coefficient of monthly log-return of $REIT_1$ and $REIT_2$. $Ln\ R_1$ and $Ln\ R_2$ refer to the monthly log-return of $REIT_1$ and $REIT_2$, respectively. The function of $Ln\ R_1$ and $Ln\ R_2$ is substitutable depends on which REITs are matched to gain the correlation coefficient. After reviewing the viability of the All-REIT portfolio based on $\rho_{1,2}$, the researchers then developed an equally weighted REIT portfolio where all 17 REITs in this

portfolio have the same weight allocation of 0.0588 (refer to Table 4). The estimated return of the All-REIT portfolio in this study can be obtained using the following:

$$E(R_p) = [W_1 \times E(R_1)] + [W_2 \times E(R_2)] + ... [W_{17} \times E(R_{17})] \quad (7)$$

Where $E(R_p)$ is the estimated return of All-REIT Portfolio, W_{1-17} is the weight of $REIT_{1-17}$ and $E(R_{1-17})$ is the estimated return of $REIT_{1-17.}$ Meanwhile, the beta of the portfolio (β_p) can be written as $\beta_p = (W_1 \times \beta_1) + (W_2 \times \beta_2) + ... (W_{17} \times \beta_{17})$ is as a result of the substitution of $E(R_1)$ to $E(R_{17})$ with β_1 to $\beta_{11.}$ Finally, variance (σ^2) is used to measure a portfolio's overall risk. Variance to calculate the portfolio risk for two assets can be depicted as $\sigma^2 = W_1^2\sigma_1^2 + W_2^2\sigma_2^2 + 2W_1W_2\sigma_1\sigma_2\rho$ while the arrangement of the portfolio variance with 17 M-REITs is as follow;

$$\begin{aligned}\sigma^2_p = \; & W_1^2\sigma_1^2 + W_2^2\sigma_2^2 + ... W_{17}^2\sigma_{17}^2 \\ & + 2W_1W_2\sigma_1\sigma_2\rho_{1,2} .... + 2W_1W_{17}\sigma_1\sigma_{17}\rho_{1,17} \\ & ..... \\ & + 2W_{16}W_{17}\sigma_{16}\sigma_{17}\rho_{16,17}\end{aligned} \quad (8)$$

Assigning Values to CAPM Variables

Historical data of M-REITs, market portfolio and r_f are required to solve the equations using CAPM. The monthly closing price of REIT from July 1, 2019, until June 1, 2021, has been obtained from the Yahoo Finance website. *Ln* have been utilised to all monthly closing price data for both REITs and market portfolios to fulfil the inputs required by the CAPM. As for the market portfolio, monthly log-returns of FBM KLCI have been assigned to the model. In Malaysia, FBM KLCI serves as a market portfolio benchmark for investors in analysing their portfolios using CAPM. SC highlighted that FBM KLCI comprises the largest 30 companies listed on the Main Board by full market capitalisation that meet the FBM Ground Rules' eligibility requirements, thus serving as the representative of the Malaysian stock market. Meanwhile, a government bond is a proxy for risk-free rate (r_f) under CAPM (Shankar, 2020; Jagannathan, 1996) and in this case, the researchers use the yield of 10-year Malaysian Government Securities (MGS) obtained from the Bank Negara website, which stood at 3.23% as of June 1, 2021. The yield of 10-year MGS was in the range of 2.54% to 3.63% during the observation period.

This study's observation period is from July 1, 2019, to June 1, 2021. The observation period covers three (3) phases such as follows; **(i) pre-COVID-19 phases** (i.e., July 1, 2019, until January 24, 2020); (ii) **COVID-19 and Pre-MCO phases** (i.e., January 25, 2020, until March 17, 2020); and (iii) **COVID-19 and MCO phases** (i.e., March 18, 2020, until June 1, 2021). At the end of the observation period (June 1, 2021), the COVID-19 cases are still being recorded by MOH, and MCO 3.0 is still being implemented in Malaysia. Table 1 shows the descriptive data of REITs Closing Price and Observation Period used in the CAPM for easy reference.

Table 1. Descriptive Data of REITs Closing Price and Observation Period

REIT Company	Mkt Cap (RM.)	REIT Closing Price (Monthly)					No. Obs.	Observation Period
		Mean	Median	Max	Min	SD.		
Al-Aqar REIT	912.62 Mil	1.37	1.36	1.51	1.28	0.07	24	
Al-Salam REIT	313.2 Mil	0.70	0.69	0.92	0.52	0.13	24	
AmFIRST REIT	271.13 Mil	0.44	0.42	0.51	0.39	0.04	24	**Pre-COVID 19 Phases:** (July 1, 2019 – January 24, 2020)
Amanahraya REIT	378.33 Mil	0.69	0.67	0.83	0.61	0.06	24	
Atrium REIT	292.61 Mil	1.14	1.07	1.50	0.92	0.16	24	**COVID-19 and Pre-MCO Phases:** (January 25, 2020 – March 17, 2020)
Axis REIT	2.806 Bil	1.94	1.94	2.17	1.72	0.13	24	
Capitaland Malaysia REIT	1.309 Bil	0.80	0.74	1.08	0.60	0.18	24	**COVID-19 and MCO Phases:** • *MCO 1.0* (Mar 18, 2020 - Jan 12, 2021) • *MCO 2.0* (Jan 13, 2021 – May 11, 2021) • *MCO 3.0:* (May 12 – June 1, 2021) *
Hektar REIT	270.25 Mil	0.74	0.64	1.03	0.54	0.19	24	
IGB REIT	5.992 Bil	1.80	1.77	2.07	1.59	0.13	24	
KIP REIT	426.98 Mil	0.83	0.82	0.90	0.77	0.03	24	
KLCC REIT	12.132 Bil	7.59	7.80	8.16	6.67	0.47	24	
Pavilion REIT	4.175 Bil	1.58	1.58	1.87	1.28	0.18	24	
Sentral REIT	953.89 Mil	0.88	0.88	1.07	0.68	0.11	24	
Sunway REIT	4.795 Bil	1.64	1.58	1.95	1.39	0.18	24	
Tower REIT	164.09 Mil	0.69	0.64	0.91	0.57	0.12	24	
UOA REIT	770.18 Mil	1.20	1.22	1.34	1.09	0.07	24	
YTL REIT	1.5 Bil	1.03	0.93	1.38	0.71	0.23	24	

Notes:

1. Market capitalisation for REIT is obtained from Malaysiastock.biz as of July 16, 2021. The closing price of REIT is taken at monthly historical data from Yahoo Finance with an observation period starting from July 1, 2019, to June 1, 2021.
2. *At the end of the study observation period (June 1, 2021), the COVID-19 cases are still being recorded by MOH, and MCO 3.0 is still being implemented in Malaysia.

RESULTS AND DISCUSSION

The outcome of the CAPM in this study is presented in Table 2. Based on Table 2, the average (avg.) monthly log-returns of M-REITs are recorded at the range of -0.0235 to 0.0111. YTL REIT recorded the lowest (min) monthly log-return during the observation period at -0.3815 on March 1, 2020, and Hektar REIT at -0.3198 on March 1, 2020. However, other REITs were also experiencing negative monthly log-returns ranging from -0.3815 to -0.0737 for a specific period. Meanwhile, Tower REIT recorded the highest (max) monthly log-returns at 0.2231 on April 1, 2020, followed by YTL REIT and Al-Salam REIT at 0.2045 and 0.1431 on November 1, 2020.

Generally, during the implementation of MCO, the average monthly log-returns of M-REITs can effectively outperform the monthly log-returns of FBM KLCI in April and November of 2020 and March and June 2021 (refer to Figure 1). Meanwhile, the remaining period was recorded at par with FBM KLCI except for March 2020, which shows a considerable deviation of monthly log-returns (Avg. M-REITs at -2.712 and FBM KLCI at -0.0872). The deviation may have resulted from a market sentiment on the federal government's transition on March 1, 2020.

The estimated risk (r) of individual REITs are recorded at the range of 0.0260 to 0.1135, and it should be noted that risk-free rate (r_f) use is constant at 3.23% based on 10-year MGS for all datasets. Meanwhile, M-REITs' systematic risk or beta recorded less than 1.0 and

ranged from -0.2002 to 0.2438, indicating that M-REITs are less volatile than the market portfolio. The firms with betas greater than 1.0 are referred to as aggressive companies, while those with 'betas' result less than one (1) are defensive (Coskun et al., 2017; Bukar & Daniel, 2020).

The estimated return of REITs $E(r_1)$ is recorded at the range of -0.1905 to 0.2391, where Sentral REIT shows the highest return at 0.2391, followed by Atrium REIT at 0.1860 and subsequently IGB REIT at 0.1858. Based on the results, only 4 out of 17 REITs shows a negative return, namely Al-Aqar REIT (-0.0455), Axis REIT (-0.0455), Capitaland Malaysia REIT (-0.1905) and KLCC REIT (-0.0141). Empirical research also emphasises that there is a probability that investors will receive a negative return when assessing the asset using CAPM. The ex-post risk premium is low (or negative) during a falling market since riskier assets tend to lose most value on average (Vendrame, Guermat, & Tucker, 2018). This negative return also indicates that the ex-ante risk premium is higher for riskier assets as lower prices imply higher future returns on average (Vendrame et al., 2018).

Table 2. Estimated Risk and Returns of M-REIT (July 1, 2019 – June 1, 2021)

Label	REIT Company	Monthly Log-Returns			Ind. Risk	Systematic Risk / Beta	Risk-Free Rate	Est. Return
		Min.	Max.	Avg.	r	β	r_f	$E(R)$
R1	Al-Aqar REIT	-0.1008	0.0588	-0.0069	0.0290	-0.0504	0.0323	-0.0455
R2	Al-Salam REIT	-0.1919	0.1431	-0.0220	0.0676	0.1621	0.0323	0.1601
R3	AmFIRST REIT	-0.1488	0.0572	-0.0106	0.0511	0.1010	0.0323	0.1010
R4	Amanahraya REIT	-0.2066	0.0635	-0.0103	0.0534	0.1765	0.0323	0.1740
R5	Atrium REIT	-0.1510	0.1071	0.0111	0.0566	0.1889	0.0323	0.1860
R6	Axis REIT	-0.0737	0.0809	0.0023	0.0455	-0.0504	0.0323	-0.0455
R7	Capitaland Malaysia REIT	-0.1417	0.0870	-0.0229	0.0470	-0.2002	0.0323	-0.1905
R8	Hektar REIT	-0.3198	0.1268	-0.0235	0.0818	0.0451	0.0323	0.0469
R9	IGB REIT	-0.2092	0.0844	-0.0050	0.0594	0.1887	0.0323	0.1858
R10	KIP REIT	-0.1343	0.0829	-0.0003	0.0416	0.1336	0.0323	0.1325
R11	KLCC REIT	-0.0813	0.0400	-0.0070	0.0260	-0.0179	0.0323	-0.0141
R12	Pavilion REIT	-0.1304	0.1218	-0.0138	0.0583	0.0705	0.0323	0.0715
R13	Sentral REIT	-0.2538	0.1120	-0.0073	0.0737	0.2438	0.0323	0.2391
R14	Sunway REIT	-0.1781	0.0615	-0.0126	0.0540	0.0430	0.0323	0.0448
R15	Tower REIT	-0.2436	0.2231	-0.0192	0.0812	0.1562	0.0323	0.1544
R16	UOA REIT	-0.0760	0.0841	-0.0074	0.0362	0.0861	0.0323	0.0865
R17	YTL REIT	-0.3815	0.2045	-0.0162	0.1135	0.1689	0.0323	0.1667

Notes:
1. Observation is based on 24 months of REIT monthly data from June 1, 2019, to June 1, 2021, and the closing prices are taken at the 1st day of each observed month.
2. The risk-free rate (r_f) is taken at 3.23 based on the trading yield of 10-year MGS as of June 1, 2021.

Previous empirical research on M-REITs in 2011 also found that in 2008, all the three M-REITs recorded a negative total return, with a maximum of -31.31% (Alias & CY, 2011). Other studies in 2012 also reveal that both conventional and Islamic REITs experienced negative monthly returns during the 2008 global financial crisis (GFC) period and positive monthly returns post GFC period (Ong et al., 2012). In other words, for this research, the estimated return of M-REITs might reach a positive value if the researchers extend the observation period into a medium or long-term analysis (>24-months) which is also the

limitation of this research. Besides that, the type of return analysed in this study is the price return and does not consider the distribution of dividends by M-REITs.

Table 3 shows the Correlation between monthly log-returns of M-REITs ($\rho_{1,2}$). Based on the results, 76 out of 136 REITs matches show a negative correlation coefficient, implying the viability of including multiple REITs in a portfolio. However, the researchers develop an equally weighted portfolio for this research. All 17 REITs have an equal weight allocation of 0.0588 to assess the fair estimated return of All-REIT portfolio $[E(R_p)]$. Finally, Table 4 depict the summary of portfolio return (0.0855), portfolio beta (0.0850) and portfolio risk (0.0015) and portfolio standard deviation (0.0392) of All-REIT Portfolio.

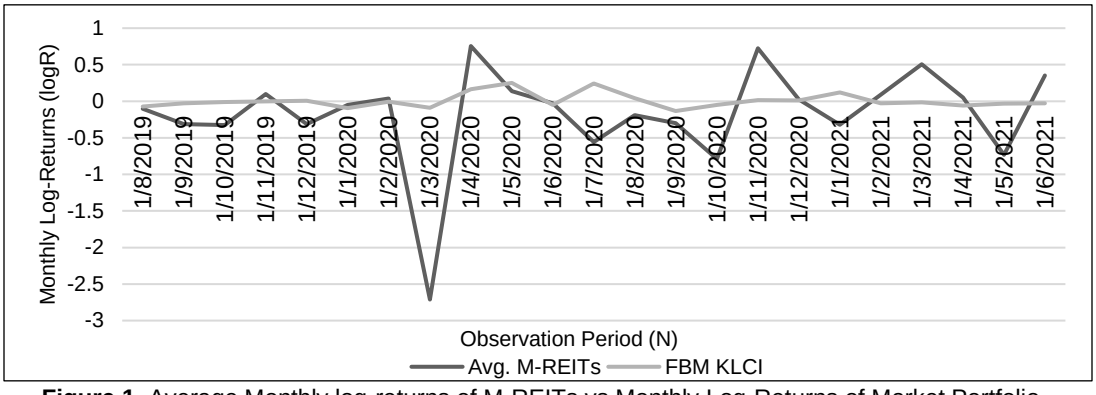

Figure 1. Average Monthly log-returns of M-REITs vs Monthly Log-Returns of Market Portfolio

Table 3. Correlation Coefficient of M-REITs Monthly Log-Returns (July 1, 2019 – June 1, 2021)

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17
R1	1.000																
R2	.070	1.000															
R3	-.281	.445*	1.000														
R4	-.075	.359	.659**	1.000													
R5	-.135	.288	.541**	.604**	1.000												
R6	-.144	.323	.534**	.363	.215	1.000											
R7	.019	.273	.380	.197	-.009	.077	1.000										
R8	-.180	.405	.524*	.763**	.436*	.054	.308	1.000									
R9	-.011	.460*	.579**	.775**	.464*	.570**	.169	.698**	1.000								
R10	-.095	.324	.494*	.616**	.636**	.243	.153	.588**	.628**	1.000							
R11	.005	.393	.232	.220	.101	.645**	.059	-.026	.398	.175	1.000						
R12	-.111	.730**	.737**	.535**	.276	.670**	.341	.508*	.606**	.317	.454*	1.000					
R13	-.133	.361	.644**	.663**	.695**	.318	.098	.542**	.635**	.712**	.275	.504*	1.000				
R14	-.052	.671**	.698**	.727**	.312	.478*	.425*	.677**	.767**	.331	.399	.812**	.499*	1.000			
R15	-.008	.242	.586**	.709**	.663**	.200	.103	.611**	.613**	.673**	.190	.360	.677**	.408	1.000		
R16	.099	.179	.213	.503*	.464*	.240	-.243	.467*	.559**	.553**	.243	.307	.404	.290	.574**	1.000	
R17	-.222	.537**	.633**	.762**	.362	.287	.340	.809**	.661**	.440*	.260	.678**	.545**	.725**	.561**	.394	1.000

Notes: *Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

Table 4. Analysis of All-REIT Portfolio

	Portfolio Return $[E(R_p)]$	**Portfolio Beta** (β_p)	**Portfolio Risk** (σ^2_p)	**Portfolio SD.** (σ_p)
Results	0.08551	0.08504	0.0015	0.0392

Notes: REITs in All-REIT Portfolio is equally weighted at 0.05882

CONCLUSION

In conclusion, CAPM suggests that M-REITs show a low deviation of performance with market portfolio during the pandemic, thus signifying that it is a low-risk investment and shall be included in any investment portfolios. Further study might assess the relationship of REITs return and historical COVID-19 proxies' data such as previous daily cases recorded or other pandemic indicators. The inclusion of dividend yield in CAPM is also helpful as REIT is usually categorised as a value investment where the focus will be on dividend pay-out by REIT companies.

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SYSTEMATIC LITERATURE REVIEW ON BUILDING ENERGY SIMULATION FOR ENERGY OPTIMISATION

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Abstract
Energy conservation measures (ECM) and energy efficiency practices promote sustainability in energy industry. Building energy simulations (BESs) is one of the tools commonly adopted to optimise energy usage in new buildings or retrofitted buildings through reduction in energy consumption and promote cost saving. Several systematic reviews have been carried out on the BESs. This article has been set out to analyse the existing literature review on BESs used towards usefulness of BESs. In minimising bias and maximizing contribution to the knowledge and increasing the citability of the article, PRISMA (Preferred Reporting Items for Systematics reviews and Meta-Analyses) was selected to use as a review method focussing on Scopus and Web of Science database of 20 related studies. PRISMA has a standard method in conducting literature review with consists of four-phase. Reviewed from 20 articles resulted in two main theme which are computer aided design and web-based design. Reviews also in identified additional main sub-theme features namely, parameters measures, origin/developer and building types. Further details on each BESs described valuable insights to helps others to decide which BESs are suitable for their study.

Keywords: *Building simulation, energy conservation measure, building performance, energy efficiency, systematic literature review.*

INTRODUCTION

Recent data strongly suggests that rapid and continuous global-scale warming is caused by human activities with the use of non-renewable and fast depleting fossil fuel energy. Hazardous carbon concentration that releases into the earth atmosphere is causing an increase to earth temperature. Construction industry has been regarded as among the highest contributor for the emission of greenhouse gases (GHG). Recent publications by Inter Governmental Panel of Climate Change further classified energy generation, transportation, industrial activities and building operations as four key industries that contributed to global GHG emission. The energy utilised during building operation in particular for heating and cooling system is regarded as causing majority of GHG emissions by building industry. Enkvist et al. (2010) projected by the end of the year 2030, total CO_2 is expected to exceed 10 billion tons. In United State (US), 30% of gas emission is caused by built environment, while the construction industry in United Kingdom (UK) contributed around 55% of their national energy consumption and CO_2 emission. As a developing country, Malaysia is heavily dependent on natural fossils fuel energy resources. By 2020 Malaysia will produce 262.2 million tons of CO_2 emissions which is higher than GDP and population (Energy Commission, 2021) with the highest annual increase at around 19.93%. Not to be lagged with other developed nations, the government has taken a bold step of promoting Sustainable Green Development. Malaysian construction industry had since gradually adopted green practices with focus on energy efficiency. The sustainable energy efficiency initiatives not only focus on construction activities but also energy efficient equipment to achieve low carbon or net zero carbon emission. Therefore, the development of tools for measuring and estimating energy consumption through simulation method is widely accepted. Availability

of various energy simulation tools allows stakeholders such as designers and building owners to predict the energy consumption prior to execution. The manuscript review in this paper is intended to assist them in selecting suitable tools to suit their specific objectives and usage pattern.

LITERATURE REVIEW

Technological advancement drives under Industrial Revolution 4.0 (I.R.4.0) offers various opportunities for the construction industry to increase mechanisation and digitalisation practices through simulation prior to the physical construction activities. Computer aided simulation tools and fast emerging web-based platform simulation tool such as Building Information Modelling (BIM) and Building Energy Simulation (BESs) are able to manage and predict related resources involve in that particular buildings. i.e.: management, energy, materials, cost etc. These simulation tools which come with licensing and updating features are very useful in designing, costing, controlling, monitoring the building lifecycle (Ghaffarianhoseini et al., 2017). For example, simulation resources such as BIM can be shown through Level of Development (LOD). LOD 100, 200, 300, 400, 500, 600, 700, 800 shows the life cycle of building started from brief, concept, model condition, scheduling, cost planning, sustainability of energy analysis, facilities management and demolition or rehabilitation of building (Azhar et al., 2012).

Majority of new buildings already adopt energy efficiency features as a requirement under local by-laws enforced by each country. For older buildings to be retrofitted with energy efficiency features is more complex and require high investments as early as simulation stage whether to use computer aided or web-based tools. It is proven that building age is one of the factors to be considered during analysis of building performance particularly in term of energy related issues (Hussin, 2020). Computer aided simulation tools had been traditionally dominating the market. However, Web-based retrofit simulation tools is being promoted by their proponents as an alternative to computer aided tools because it offer wider virtual accessibility that encourage the adoption of energy efficiency measures by furnishing energy and cost savings estimates (Lee et al., 2014). Retrofit application such as ECMS (Energy Conservation Measures) offer common features to simulate electrical consumption for lighting, building envelope, equipment, HVAC (Heating Ventilation and Air Conditioning System), hot water and occupancy profiles. Example of ECMs simulation outputs to improve energy efficiency includes installing day lighting sensors for interior lighting control, replacing wall and ceiling, or roof insulation, upgrading an HVAC rooftop unit with a high efficiency unit, adding an economizer, or upgrading to LED lights (Associates, 2005). Computer aided based simulation tools traditionally been dominating the practices in building sector by performing energy diagnostics and evaluation to guide decision making for energy efficiency building. However the emerging of web based apps for energy simulation tool is proving to be a reliable alternative with increasing capabilities of online services with regular updates to follow latest technological advancement (Pérez-Lombard et al., 2009). Lee, Hong, Sawaya, Chen, & Piette, (2015) suggested that retrofit analysis toolkits can provide an appealing interface for user input data and a graphical display of the outputs. It can also provide underlying engineering algorithms based on physical principles to calculate the thermal dynamics of components or at the whole building scale. Zhao & Magoulès, (2012) suggests that predicting energy performance of building is challenging as it is influenced by building physical characteristics, the structural design, climatic conditions, sub components

systems, and most importantly how building occupants use the sub components systems (lighting, HVAC, equipment etc.). The quality of outputs from energy analysis simulation tools for building whether in simplified format more complex dynamic format depend on scope of study, accuracy of input, user's skill, speed of simulation and time and cost factors (Pérez-Lombard et al. (2009); Al-Homoud (2001)). All energy simulation tools share the same objective of analysing energy building performance in order to give positive impacts to the environment (King et al., 2020).

METHODOLOGY

The methodology involved selection of existing related articles that reviewed computer aided tools or web-based platforms for building simulation tools. The articles were sourced from Scopus and Web of Science. Systematic review of retrieved articles used a method called PRISMA that will automatically run the eligibility and exclusion criteria, steps of the review process (identification, screening) and data abstraction and analysis. PRISMA, an abbreviation for Preferred Reporting Items for Systematic reviews and Meta-Analyses is a method that focuses on reporting of reviews or systematic reviews for various types of research in particular for evaluations and interventions. The main advantage of PRIMA Statement method is that it can define clear research questions systematically by identifying inclusion and exclusion criteria as it attempts to examine large database of scientific literature review in a defined time, well-described procedure can facilitate the understanding and appraisal of reviewing methods (Moher et al., 2015). PRISMA is suitable for this research as it allows rigorous search related to building simulations available in the industry.

Scopus and Web of science (WoS) are the main source of journal database for selection of related articles in this research. WoS has a wide range of database with more than N22, 200 journals in the interdisciplinary fields of social science, art and humanities, social issues, development and planning. Conference proceeding is the highest number indexed by WoS which is 205,000 conferences recorded. Their archives have over 115 years of comprehensive back file and citation data, established by Clarivate Analytics and ranks them by three separate measures: citations, papers, and citations per-paper. Meanwhile, Scopus covers diverse area of environmental science and social science has one of the largest abstracts and citation databases of peer reviewed literature with N22800 journals from 5,000 publishers worldwide. Scopus consists of diverse subject areas such as environmental sciences and social sciences and records back to 1788.

Eligibility and Exclusion Criteria

Eligibility and exclusion criteria for this research focus on four areas namely; literature type, language, time line and research index. On literature type; only article journals with empirical data are selected while review articles, book series, chapter in books and conference proceedings are excluded. On language; only article written in English are selected while non-English articles are not selected to avoid any confusion during translation process. On timeline; articles published for the last five years from 2015 until 2019 are selected to obtain the latest and most relevant information related to the research topic of building energy simulations by using computer aided design and web-based platform. Finally on research indexes; only articles from social science-based index while articles published in a hard science index (science Citation Indexed Expanded are excluded).

Table 1. The Inclusion and Exclusion Characteristics

Criteria	Eligibility	Exclusion
Literature type	Journals	Journals (systematics review), book series, book, chapter in book, conference proceeding.
Language	English	Non-English
Timeline	2010-2019	<2010
Indexes	Social Science Citation Index, Emerging Source Citation Index, Art and Humanities, Energy and Environmental Science (Web of Science)	Science Citation Indexed Expanded (Web of Science)

Systematic Review Process

Systematic review process consists of four stages with the initial stage start on January 2020. The first stage was identifying the keywords relying mainly on previous studies and thesaurus which contained similar keywords to the topic of research; building energy simulations, advance energy tools, computer aided design and web-based design. The first stage process as shown in table 2 managed to identify eight duplicated articles which were then removed.

Table 2. The Search String Used for The Systematics Review Process

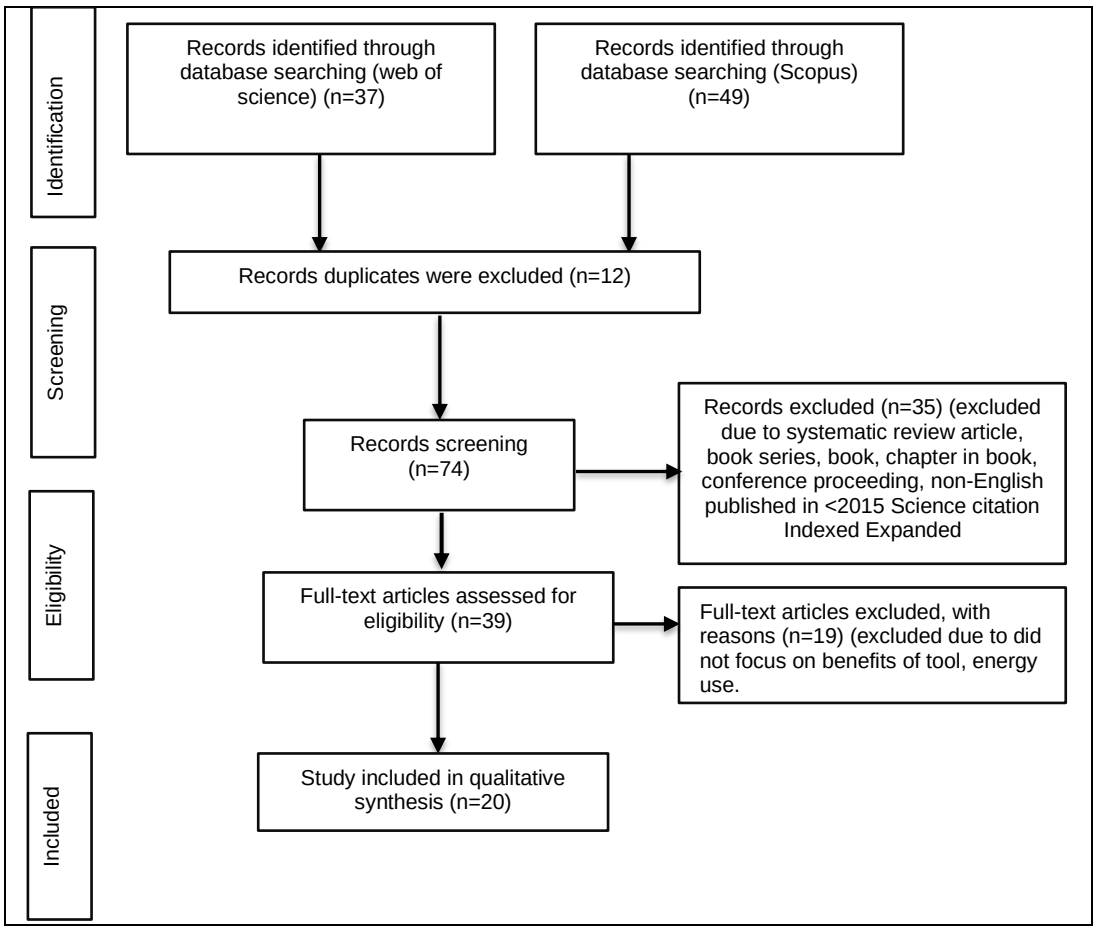
Database	Keywords used
Scopus	TITLE-ABS-KEY ((“Building* energy simulation*” OR “advance* energy tool*”) AND (“computer aid* design*”) AND (“web based”))
Web of Science	TS= ((“Building* energy simulation*” OR “advance* energy tool*”) AND (“computer aid* design*”) AND (“web based”))

The second stage was screening. At this stage, out of 86 articles eligible to be reviewed, a total of 35 articles were removed. The third stage is eligibility, where the full articles were accessed. After careful examination, a total of 19 articles were excluded as some did not focus on benefit of simulation or tools and energy use particularly. The last stage of review resulted in a total of 20 articles that were used for the qualitative analysis (see Figure 1).

Screening process during second stage managed to remove 47 articles out of a total of 86 eligible to be reviewed. While eligibility process during the third stage manage to further exclude 19 articles as some of them did not focus on benefits of tools for energy simulation in buildings. Finally, review process during fourth stage manage to narrow down the final 20 articles eligible for quantitative analysis as shown in Figure 1.

Data Abstraction and Analysis

The process for data abstraction and analysis of the 20 final selected articles concentrated on specific studies that responded to the formulated questions. It involved reading through the abstract first and then the full articles in depth to identify the appropriate theme and sub themes. Qualitative analysis involved content analysis to identify the main theme related to computer aided design and wed based design. The sub-themes around the main theme were then organized by various headings in term of features, parameter measures, developer and types of building.



(Adaption from Moher, 2009)

Figure 1. The Flow Diagram of The Study

RESULTS

Toolkits Using Empirical

In predicting building energy usage, data driven methods have been widely accepted even for simple benchmarking purpose to a more complex regression modeling. The methods rely on real measured data, smart meter data and pre-defined databases for benchmarking. Therefore, it is able to relate building design and the building operational parameters with the energy consumption. However, data driven methods have their own challenges namely; (1) the requirement of having training data to develop the model, (2) application is limited to a specific building and may not be applicable to other buildings, and (3) there lacks a physic explanation of certain parameters of the building performance.

The review resulted in two main themes and 4 sub-themes related to energy simulation tool. The two main themes are computer aided design and web-based design with (four sub-themes), simulation features, parameters measures, origin/developer and types of building that study had been used (Table 3). The results provided a comprehensive analysis of the availability of building energy simulation tools.

THE FINDINGS A ND DISCUSSION

Table 3. The Findings

Authors	Tool Information	Platform	Origin	Features	Parameters Measures	Types of Buildings	Finding
Hong et al., (2015), Lee, et al., (2015), Foldager, et al., (2019)	Commercial Building Energy Asset Scoring Tool (CBES)	Web based	U. S	Online tool Creating building geometry	Lighting, building envelope, HVAC, hot water, operating schedule	1.Office, 2. Office & commercial building (Small & medium size) 3.Residential	Energy saving, cost saving
(Granderson et al., 2016)	Simuwatt Energy Audit	Web based	U. S	A repository of energy data for ECMs. Walk through technology	n/a	Office	Energy saving, lighting quality
DeGraw, at al., (2018)	BuildingSync	Web based	U. S	Facilitate, aggregated and analyse energy audit between difference tools (companies). Asset Score Reporting platform, SEED platform and Open studio	Energy audit	Office	Energy saving, cost saving
Kim, et al., (2015) Safari & Asadi, (2019)	Consortium for Building Energy Innovation (CBEI)	Web based	U. S	Accessible to the public	Lighting, building envelope, plug loads, HVAC, hot water, occupancy	1.Office 2.Commercial building	Energy saving, water saving
Eley, (2016), Maile, et al., (2015)	California Building Energy Code Compliance for Commercial (CBECC)	Computer aided design	U. S	Stand-alone. Accessible to public, geometric creation, simulating data by EnergyPlus	Lighting, building envelope, HVAC hot water, operating schedule	Office	Energy saving, cost saving
Fraternali et al., (2017)	Encompass	Web based	U. S	Accessible to public. Benchmark energy from CBEC 2003 and ENERGY STAR	Lighting, building envelope, HVAC, hot water, occupancy, operating schedule	Office	Energy saving, cost saving
Chen, et al., (2017), (Sun, et al., (2016)	Commercial Building Energy Saver (CBES)	Web based, open source	U. S	Accessible to the public, free, simple graphical interfaces	Lighting, building envelope, HVAC, hot water, occupancy, operating schedule	Office	Energy saving, cost saving
Lee, et al., (2015) (Mao, Pan, & Fu, 2016)	Commercial Building Analysis Tool (COMBAT)	Computer aided design	China	Simplified input, stand-alone, simulating data by EnergyPlus	Lighting, building envelope, HVAC	Office	Energy saving, cost saving
Lei & Bergés, (2015)	EnergyIQ	Web based	U. S	Public use	Lighting, building envelope, HVAC, hot water	Office	Energy saving, GHG, cost saving
Lin, et al., (2019), Mushtaha, et al., (2019)	Integrated Environmental Solution (IES)	Web based	U. K	Single platform, user friendly, integrated to Autodesk Revit	Sunlight, heat radiation, cooling load, energy consumption, indoor airflow, daylight	1.Commercial building, 2. Educational building	Energy saving, cost saving, lighting quality

Authors	Tool Information	Platform	Origin	Features	Parameters Measures	Types of Buildings	Finding
Paramita, Rabbani, & Sari, (2019), Mokrzecka, (2018), Qadir, Haddad, & Hamdan, (2019)	Sefaira	Web based	U. S	Simple processes tool, integrated to SketchUp, value for money	Lighting, thermal comfort, plug loads, energy analysis, HVAC	1.Museum, 2.Dormitories, 3.Residential	Energy audit, energy saving, cost saving

From Table 3, there is a total of 20 publications reviewed 11 different software with 9 USA origins, 1 UK and 1 China origin using offices, commercial buildings, residential and museum for the type of buildings for energy simulation. This suggests that USA is leading the world with energy simulation process and possibly also leading in term of software development for energy simulation tools. Most of energy simulation tools are developed through grants initiated by United State Secretary of Energy (USSE) under the Department of Energy (DOE). The existence of these tools had been recorded as early as 1977 shows that USA is ahead in managing their energy resources to cope with rapid development and to reduce negative impact to the environment. Among the tools initiated by DOE are Commercial Building Energy Asset Scoring Tool (CBES), Simuwatt Energy Audit and California Building Energy Code Compliance for Commercial (CBECC). DOE also collaborated with private energy consultants to expediate government objectives in sustainability by developing other energy simulation tools such as Building Sync, Consortium for Building Energy Innovation (CBEI), Encompass and Commercial Building Energy Saver (CBES). Some industry players had also developed the own tools on their own initiatives. One example is Sefaira software being developed by Trimble, a well-known private company specializing in digitalisation since 1978. The Sefaira energy simulation tool is an extension to Trimble's existing architecture computer aided tool (CAD) called Sketchup. Therefore, CAD design under Sketchup can be simulated for energy performance using the Sefaira tool. This allows for smooth transitional process of building design and building energy simulation as both software are under the same platform. The DOE of USA had also shared the expertise in energy simulation through international collaboration. For example, Building Analysis Tool (COMBAT) is developed by China through collaboration with the DOE of USA. Other nation had also been developing their energy simulation tools. For example, Integrated Environmental Solution (IES) from UK was developed from an initial Don Mclean's PhD work by group or researchers from the local universities with full supports by the UK government. Three publications reviewed computer aided for 2 types of simulation tools while 17 publications reviewed web-based platform for 8 types of simulation tools which suggest that web-based platforms are fast emerging closing the rank with computer aided tools. The suitability of each tool will depend on the targeted criteria.

The findings suggest that most tools are capable for energy-saving and cost-saving while some are capable to simulate energy audit, GHG emission and lighting quality. Common parameters capable of being measured by each tool are HVAC, building envelope and lighting. Special simulation parameters available on certain tools include hot water, energy analysis, plug load, thermal comfort and operating schedules. Features which may impact on the selection of energy simulation tool are ease of access, ease of operation and usage with value for money. With current digital age, web-based software easily accessible to public may

appeal wider consumer base. The findings and outcomes from each simulation tools which are based on the required parameters should comply with all the standard guidelines set by both international and national standards i.e.; ASHRAE for international level and MS 1525-2019 for national. Therefore, the simulation results from these tools will give maximum results in terms of energy analysis.

FUTURE DIRECTION

Future research aim is to come up with comprehensive analytical approach tabulation with wider reference that may ease procurement process for selecting energy simulation tools to suit building operators during energy retrofit and energy audit covering all different criteria including specific simulation capabilities of each simulation tools.

CONCLUSION

Energy simulation is becoming a common process during building design stage. New buildings are already being subjected to compliance on energy efficiency features during approval process and therefore the result can be predicted before construction. Older buildings undergoing energy retrofitting is a huge investment with minimal margin for errors. The simulation should be able predict the targeted outcomes in order to reduce risk and to determine the return of investment. In selecting simulation tool for existing building energy retrofit, the operators must identify the criteria and features to be simulated and including the targeted outcomes to suit the investment and this study which adopted systematic literature review method had achieved the objective of demonstrating the analytical comparative process of selecting an energy simulation tools.

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GUIDE TO AUTHORS

Aims and Scope:

The Malaysian Construction Research Journal (MCRJ) is the journal dedicated to the documentation of R&D achievements and technological development relevant to the construction industry within Malaysia and elsewhere in the world. It is a collation of research papers and other academic publications produced by researchers, practitioners, industrialists, academicians, and all those involved in the construction industry. The papers cover a wide spectrum encompassing building technology, materials science, information technology, environment, quality, economics and many relevant disciplines that can contribute to the enhancement of knowledge in the construction field. The MCRJ aspire to become the premier communication media amongst knowledge professionals in the construction industry and shall hopefully, breach the knowledge gap currently prevalent between and amongst the knowledge producers and the construction practitioners.

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CODIFICATION AND APPLICATION OF SEMI-LOOF ELEMENTS FOR COMPLEX STRUCTURES

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[2] Institute of Ocean and Earth Sciences (IOES), University of Malaya, Malaysia

Abstract (Arial Bold, 9pt)
Damage assessment …… ……(Arial, 9pt. Left and right indent 0.64 cm, it should be single paragraph of about 100 – 250 words.)

Keywords:(Arial Bold, 9pt) *Finite Element Analysis; Modal Analysis; Mode Shape; Natural Frequency; Plate Structure (Time New Roman, 9pt)*

HEADING 1 (Arial Bold + Upper Case, 11pt)

Heading 2 (Arial Bold + Lower Case, 11pt)

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Body Text: Times New Roman, 11 pt. All paragraph must be differentiated by 0.64 cm tab.

Figures: Figures should be in box with line width 0.5pt. All illustrations and photographs must be numbered consecutively as it appears in the text and accompanied with appropriate captions below them.

Figures caption: Arial Bold + Arial, 9pt. should be written below the figures.

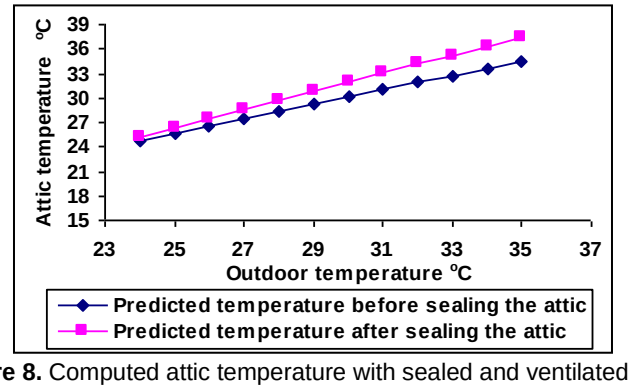

Figure 8. Computed attic temperature with sealed and ventilated attic

Tables: Arial, 8pt. Table should be incorporated in the text.

Table caption: Arial Bold + Arial, 9pt. Caption should be written above the table.

Table Line: 0.5pt.

Table 1. Recommended/Acceptable Physical water quality criteria

Parameter	Raw Water Quality	Drinking Water Quality
Total coliform (MPN/100ml)	500	0
Turbidity (NTU)	1000	5
Color (Hazen)	300	15
pH	5.5-9.0	6.5-9.0

(Source: Twort et al., 1985; MWA,1994)

Units: All units and abbreviations of dimensions should conform to **SI standards.**

Citation:

Passage Type	First reference in text	Next reference in text	Bracket format, first reference in text	Bracket format, next reference marker in text
One author	Walker (2007)	(Walker, 2007)	(Walker, 2007)	(Walker, 2007)
Two authors	Walker and Allen (2004)	Walker and Allen (2004)	(Walker & Allen, 2004)	(Walker & Allen, 2004)
Three authors	Bradley, Ramirez, and Soo (1999)	Bradley et al. (1999)	(Bradley, Ramirez, & Soo, 1999)	(Bradley et al., 1999)
Four authors	Bradley, Ramirez, Soo, and Walsh (2006)	Bradley et al. (2006)	(Bradley, Ramirez, Soo, & Walsh, 2006)	(Bradley et al., 2006)
Five authors	Walker, Allen, Bradley, Ramirez, and Soo (2008)	Walker et al. (2008)	(Walker, Allen, Bradley, Ramirez, & Soo, 2008)	(Walker et al., 2008)
Six or more authors	Wasserstein et al (2005)	Wasserstein et al. (2005)	(Wasserstein et al., 2005)	(Wasserstein et al., 2005)
Organisation (easily identified by the initials) as the author	Sultan Idris Education University (UPSI, 2013)	UPSI (2013)	(Sultan Idris Education University [UPSI], 2013)	(UPSI, 2013)
Organisation (No abbreviation) as the author	Pittsburgh University (2005)	Pittsburgh University (2005)	(Pittsburgh University, 2005)	(Pittsburgh University, 2005)

(Source: UPSI, 2019)

Reference: Times New Roman, 11pt. Left indent 0.64 cm, first line left indent – 0.64 cm.

References should be listed in **alphabetical order**, on separate sheets from the text. In the list of references, the titles of periodicals should be given in full, while for books should state the title, place of publication, name of publisher, and indication of edition.

Johan, R. (1999) Fire Management Plan for The Peat Swamp Forest Reserve of North Selangor and Pahang. In Chin T.Y. and Havmoller, P. (eds) Sustainable Management of Peat Swamp Forests in Peninsular Malaysia Vol II: Impacts. Kuala Lumpur: Forestry Department Malaysia, 81-147.

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