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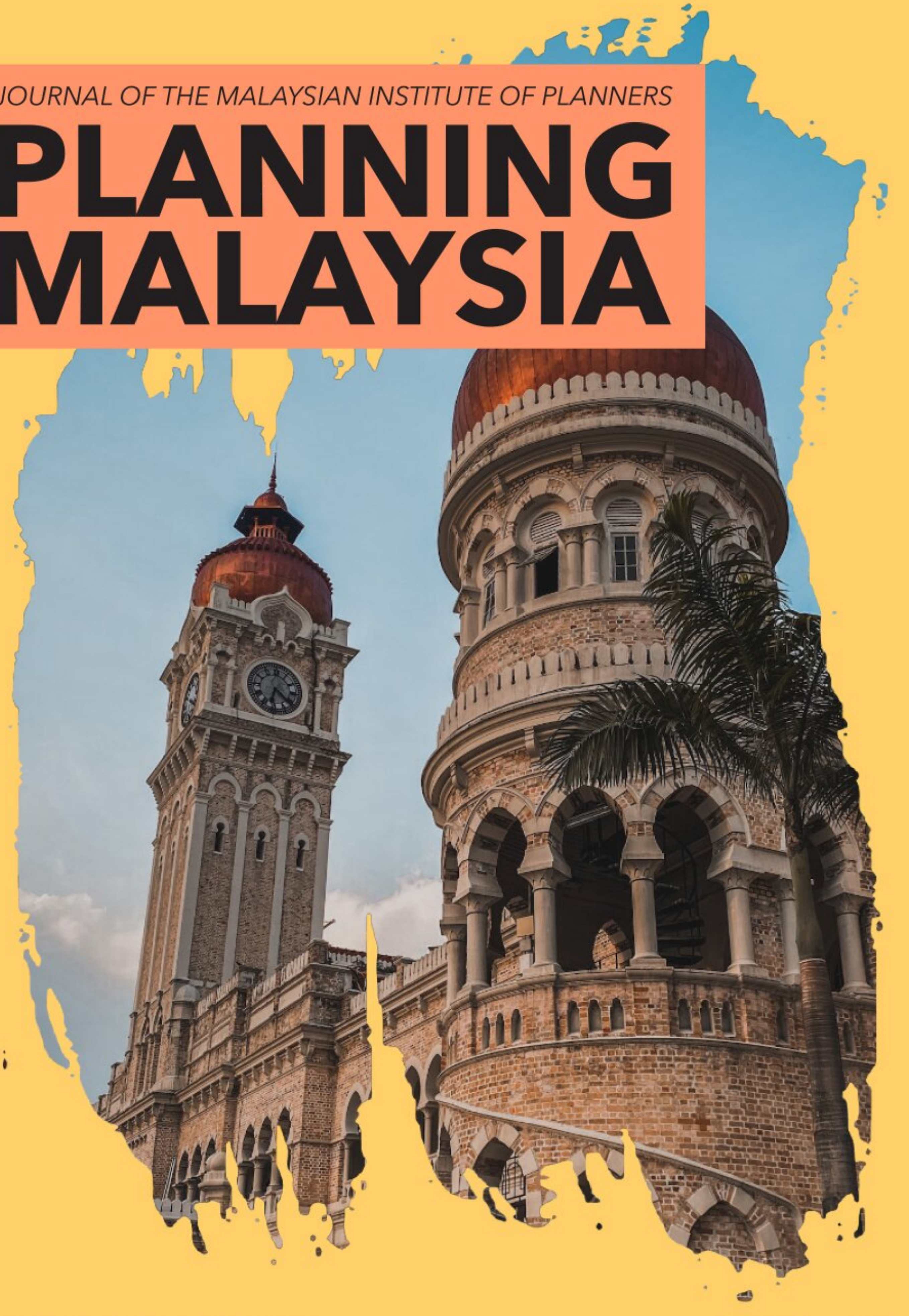

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ANALYSIS OF FLASH FLOOD POTENTIAL INDEX (FFPI) AND SCENARIOS ASSESSMENT IN SHAH ALAM USING GIS APPROACH

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Abstract

Nowadays, there is an increase in the frequency of flash floods, which can have disastrous effects on both the economy and people's lives. In this study, the flash floods in Shah Alam are analysed using the Flash Flood Potential Index (FFPI) assessment method, which utilises four significant parameters, namely ground slope, land use, soil type, and NDVI, as outlined in the FFPI model that was first developed in 2003. The study reveals that the study area has a medium risk of flash floods, with an index value of five (5) to six (6). Flash flood risk is considered in all study scenarios, with a probability of over 50%. Scenario 2 produces the best results, with a 71% chance of Shah Alam being hit by a high-level flash flood and a 22% chance of being hit by a medium-level flash flood. Since the FFPI is a dimensionless index ranging from 1 to 10, and the percentage of FFPI in Shah Alam is 47.48% for the value of 5 (median index), it is concluded that Shah Alam is in the medium risk group for daily flash floods. The FFPI is a suitable index to be used in Malaysia for predicting urban flood risk. Additionally, it is recommended to incorporate the calculation of factors or parameters that contribute to flash floods using weighting and ranking, particularly related to the drainage system and precipitation.

Keywords: Flash Flood, Shah Alam, Flash Flood Potential Index, Geographic Information System, GIS, Remote Sensing

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INTRODUCTION

Floods, haze, and drought are among the mild climate-related disasters commonly experienced in Malaysia, but floods are known to have severe socio economic repercussions on the nation. The effects and scenarios of climate change in Malaysia are significant, evident in changes in temperature, heavy rainfall, impacts on human health, changes in coastal areas, sea-level rise, effects on biodiversity, changes in land cover, availability of water resources, and crop productivity (Rahman, 2018). Flash floods are the most destructive natural disaster in Malaysia, particularly in urban areas, and have become increasingly evident to metropolitan populations, causing infrastructure damage, injuries, economic disruptions, and disruptions to daily routines (Abdul Malek et al., 2020).

In recent decades, Malaysia has been hit by various extreme weather and climatic events, such as La Niña and monsoons in Kuala Lumpur and Selangor in December 2011 (The Star, 2011). On December 27, 2021, Malaysia's floods resulted in the highest-ever unpredictability, with 48 fatalities reported (Bernama, 2021). Flash floods, which occur quickly, can cause severe economic and fatal damages, despite their rarity (Bhuiyan et al., 2021), with land factors and heavy rain as the major contributors (Muhamed Noordin et al., 2007). Recent flood monitoring efforts have heavily relied on remote sensing and GIS, focusing on delineating flood zones, creating flood hazard and risk maps for vulnerable locations. This integration of knowledge and technology has already been applied in other places, such as Ethiopia (Bishaw, 2012). In this study, GIS techniques and the Flash Flood Potential Index (FFPI) were employed to identify flash flood factors, understand flash flood locations, classify flash flood risk levels, and verify flash flood classifications using historical data and remote sensing images in Shah Alam.

DATA AND METHODS USED FOR FFPI

Data Collection for Flash Flood Potential Index (FFPI)

The data are both in vector and raster format. Table 1 shows the data collected for the classification of flash flood potential and meanwhile the data collected for the verification is from this source https://browser.creodias.eu.

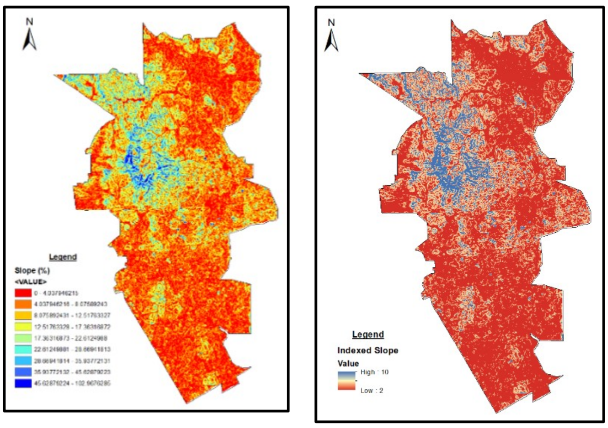
Table 1: Data Collected and Used For FFPI

Datasets	DEM	Soil type	Landcover	Vegetation
Sources	Shuttle Radar Topography Mission (SRTM) [2015]	Digital Soil Map of the World (DSMW) [2007]	Land Use/Land Cover (LULC) [1/2/2021]	Landsat-8 [7/2/2021]

Source: United States Geological Survey (USGS), Food and Agriculture Organization (FAO) & ESRI

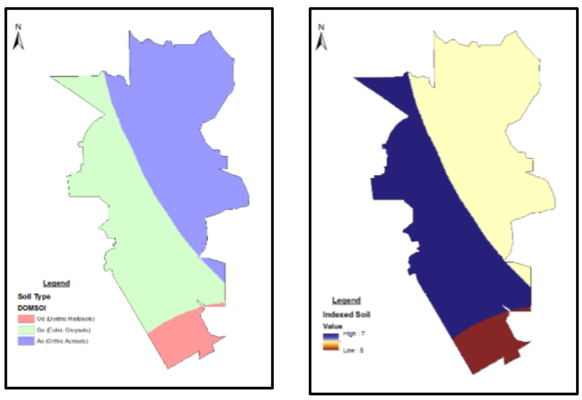
Data Preparation for FFPI

This study utilised four different parameters of data in accordance with the Flash Flood Potential Index (FFPI). These factors include slope, soil, land use/land cover (LULC), and vegetation index of NDVI, which were prepared and classified in accordance with FFPI requirements, as shown in Table 3. Slope is a crucial element as it controls runoff. Figure 1(a) displays the slope percentage of the study area, while Figure 1(b) shows the FFPI-reclassified slope. Figure 2(a) depicts the soil types in the study area, with Orthic Acrisols being clay-rich acidic soils with deep, loamy, dark brown soil and Dystric Histosols containing over 14% organic matter. Eutric Gleysols are water-saturated, non-salted soils. The reclassified soil map is displayed in Figure 2(b).



(a) (b)

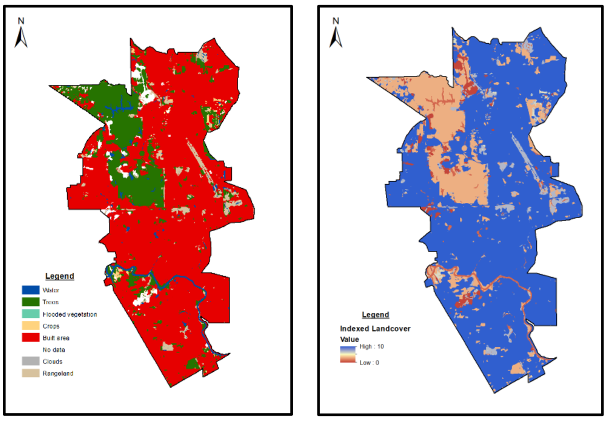
Figure 1: Slope Factor of FFPI: (a) Slope Map, (b) Reclassified Slope Map
Source: Author's Output



(a) (b)

Figure 2: Soil Factor of FFPI: (a) Soil Map, (b) Reclassified Soil Map
Source: Author's Output

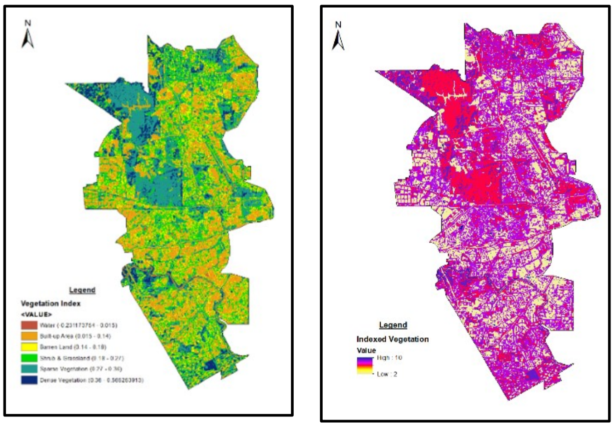
The type of land use and land cover (LULC) for the study area is shown in Figure 3(a). In Shah Alam, the majority of the land is covered by built-up areas such as buildings, roads, and highways, which make the surface less permeable to water. Figure 3(b) shows the reclassification of LULC used in FFPI. The vegetation index of NDVI uses red and near-infrared wavelengths to enhance vegetation features and canopy structure through spectral imaging transformation. By using NDVI and satellite images, the extent of flooding can be estimated for various flood occurrences. Figure 4(a) shows the vegetation index of the study area, while Figure 4(b) displays the reclassified NDVI factor.



(a) (b)

Figure 3: Landcover Factor of FFPI: (a) Landcover Map, (b) Reclassified Landcover Map

Source: Author's Output



(a) (b)

Figure 4: Vegetation Factor of FFPI: (a) Vegetation Map, (b) Reclassified Vegetation Map

Source: Author's Output

Calculation of FFPI

In 2003, the FFPI was developed by the National Weather Service's Colorado Basin River Forecast Centre, which takes into account slope, vegetation cover/density, soil texture, and land use (Smith, 2003). The FFPI is generated by collecting raster datasets of these attributes across the region of interest and then using GIS technology to resample, reclassify, and combine the data. Figure 5 illustrates the steps involved in processing the data using the FFPI approach. The result is a numerical index that indicates a region's potential for flash flooding, which remains relatively static over time.

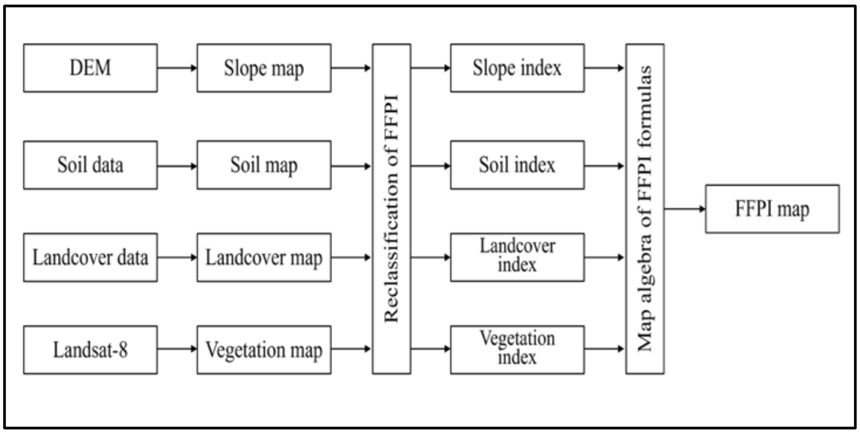


Figure 5: Methodology Flow Chart Using FFPI.
Source: Author's Illustration

A GIS can be utilised to classify, compare and assess the intrinsic flash flood potential of a particular drainage basin to provide quantitative information (Kruzdlo & Ceru, 2010). The hydrologic response attributes of each data layer were assigned a flash flood potential index ranging from 1-10. In the previous study, an equal interval classification was used (Arachchige & Perera, 2015). Each factor was given a score between 1 and 10 on the index, where a value of 1 indicates a low probability of flash floods, and a value of 10 indicates the highest probability. Table 2 displays the FFPI values assigned to each dataset based on its sensitivity to flash flooding.

Table 2: Assigned FFPI Values on Each Dataset Depending on The Susceptibility for Flash Flooding

FFPI value	Slope/DEM (%)	Land use	Vegetation cover (%)	Soil type
1	3 and below	Water	90 – 100	Water/Alluvial
2	6	Woody Wetlands, Herbaceous Wetland	80 – 89	Sand
3	9	Evergreen Forest	70 – 79	Sandy Loam

4	12	Mixed Forest	60 – 69	Silty Loam, Loamy sand
5	15	Deciduous Forest	50 – 59	Silt/Organic matter
6	18	Pasture Hay, Cultivated	40 – 49	Loam
7	21	Developed/open space, Barren Land	30 – 39	Sandy Clay Loam, Silty Clay Loam
8	24	Developed/low	20 – 29	Clay Loam, Sandy, Clay
9	27	Developed/medium	10 – 19	Clay
10	30 and above	Developed/heavy	0 – 9	Bed, Rock/Impervious

Source: (Smith, 2003), (Kruzdlo & Ceru, 2010), (Arachchige & Perera, 2015), (Brewster, 2004), (Smith, 2010), (Minea, 2013), (Zogg & Deitsch, 2013) & (Shawaqfah et al., 2020)

Smith (2003) introduced the factors or parameters of the FFPI which have since been utilised by numerous researchers, as presented in Table 3. An updated version of the FFPI assigned greater importance to slope than to vegetation cover, resulting in a higher likelihood of flash floods occurring in areas with steeper slopes (Brewster, 2009). The most significant change was that each component was given an equal weighting (Kruzdlo & Ceru, 2010). Another modification was that more emphasis was placed on a slope as well as land cover/use (Ceru, 2012).

The generation of the FFPI map involves the use of raster map algebra in the Spatial Analyst tool within ArcGIS. Different formulas are employed for four scenarios, as depicted in Table 3, to determine the flash flood potential using the FFPI approach. Upon computation of the FFPI, a second reclassification step is conducted to determine the severity of the risk level associated with the possibility of flash flooding.

Table 3: Equations Used for FFPI Scenarios

Scenario	Equation used	Factors used	Notes
1	$\frac{(1.5M + L + S + V)}{4.5}$	Slope, land cover, soil type, vegetation cover	(Smith, 2003)
2	$\frac{(1.5(M) + L + S + 0.5(V))}{4}$	Slope, land cover, soil type, vegetation cover	(Brewster, 2009)
3	$\frac{(M + L + S + V)}{4}$	Slope, land cover, soil type, vegetation cover	(Kruzdlo & Ceru, 2010)
4	$\frac{(2(M) + 2(L) + S + V)}{6}$	Slope, land cover, soil type, vegetation cover	(Ceru, 2012)

Source: (Shawaqfah et al., 2020)

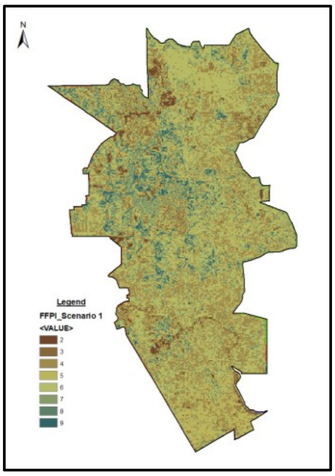
Verification of Results Using Historical Flood Data

After the FFPI classification is completed, verification is carried out using historical data from remote sensing imagery that correspond with flash flood events. To observe flood situations from space, the active satellite data system, Spaceborne Synthetic Aperture Radar (SAR), is widely used as it can penetrate cloud coverage, operate during day and night, and function effectively during adverse weather conditions like heavy rainfall. The software provided by Sentinel, SNAP software, is utilised to process this satellite imagery. Another method employed for the verification of the FFPI classification is Kernel Density, which is used to locate the hotspot area based on the obtained historical flood data. Historical flood information for Shah Alam was obtained from the Selangor Department of Irrigation and Drainage in the form of vector data presented as points.

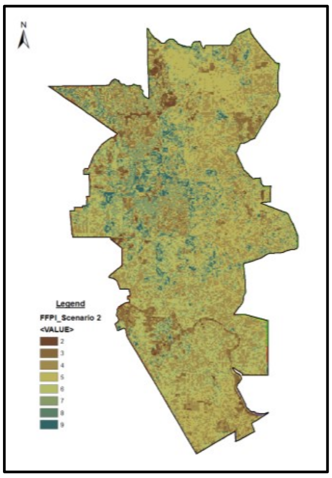
RESULTS AND DISCUSSIONS

Four Scenarios FFPI in Shah Alam and Percentage Area of FFPI Value

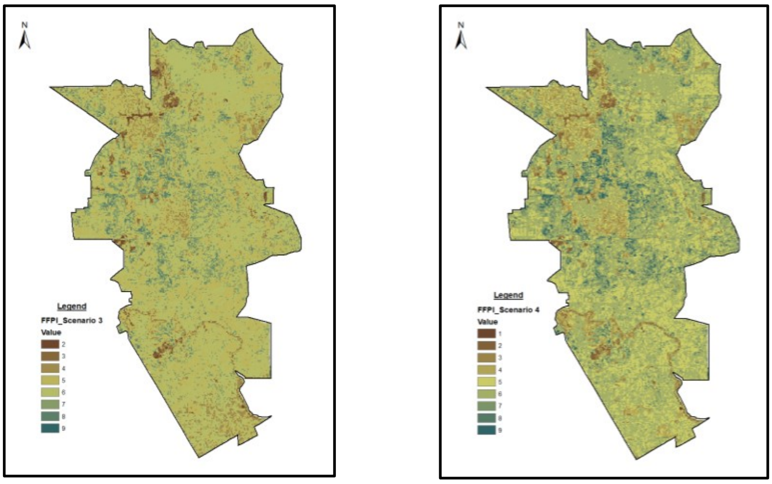
Figure 6(a) to 6(d) show the result from the first, second, third and fourth equations of FFPI used respectively as described in Table 4 and known as Scenario 1, Scenario 2, Scenario 3, and Scenario 4. The figures range from the value 2 to 9 of the index in Table 3 where the lowest potential is in the dark brown colour and the highest potential is in the dark green colour. These figures show that most of the study area is classed as having a medium potential value for flash floods, with values ranging from 5 to 6.



(a)



(b)



(c) (d)

Figure 6: FFPI of Shah Alam: (a) Scenario 1, (b) Scenario 2, (c) Scenario 3, (d) Scenario 4.

Source: Author's Output

The area of the FFPI value in each scenario is calculated in the form of percentage as shown in Table 4. The outcomes from each scenario indicated that the potential index of flash flood is in the middle of the range spanning from the least potential to the most potential. On the other hand, Scenario 3, and Scenario 4 have values that range from five to seven as the highest possible within the scenario itself. Both hypothetical situations cover more than 40% of the research field when the FFPI is set to six. It appears that both outcomes place the study area at a medium risk of experiencing a flash flood. Areas at medium risk include Setia Alam, Sections 2, 19, 23, and Bukit Kemuning, which are overlayed on a base map.

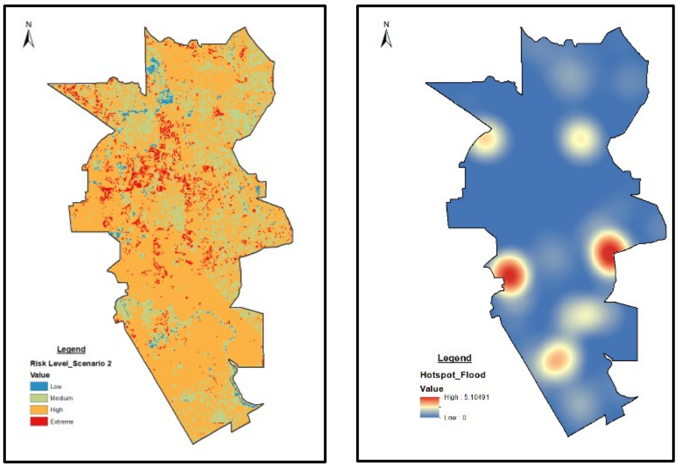
Table 4: Percentage of Area in FFPI Scenarios

FFPI	Percentage of area belong to different FFPI values (%)			
	Scenario 1	Scenario 2	Scenario 3	Scenario 4
1	0.00	0.00	0.00	0.01
2	1.03	0.78	0.78	1.50
3	1.53	3.85	1.38	4.65
4	27.51	9.91	7.15	7.65
5	23.93	47.48	34.28	25.91
6	36.51	28.29	40.28	43.70
7	7.63	7.09	13.62	12.42
8	1.85	2.13	2.48	2.90
9	0.01	0.47	0.01	1.25
10	0.00	0.00	0.00	0.00

Source: Author's Calculation

Comparison of FFPI Risk Level with Hotspot Area of Historical Data of Flash Flood Occurrence

The analysis of historical data is conducted to identify the area where flash floods frequently occur during the years of interest. The hotspot region of flash floods in Shah Alam is depicted in Figure 7(a). By comparing it to Figure 7(b), it can be observed that the hotspot area of flash flood occurrence lies within the high-risk region susceptible to flash flooding. However, the area with the highest potential for flash flooding, i.e., the extreme-risk area, does not overlap with the hotspot area of flash flood occurrence. This area has experienced infrequent flooding events, as per the past data.

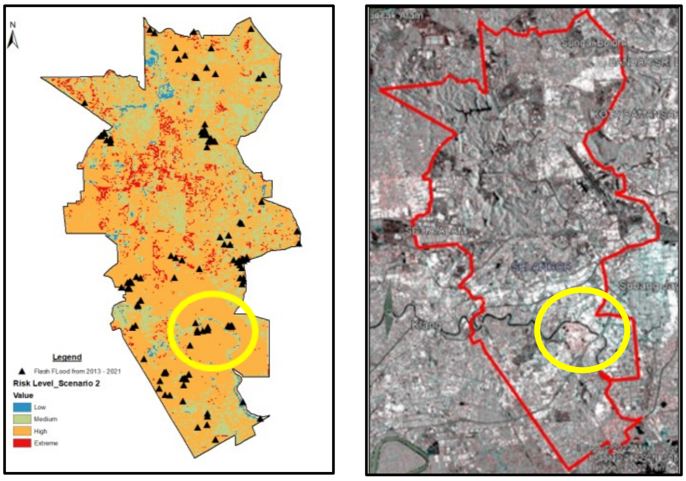


(a) (b)

Figure 7: Comparison of Outcomes: (a) FFPI Risk Level, (b) Hotspot Area of Historical Data
Source: Author's Output

Comparison of Historical Data of Flash Flood Occurrence with FFPI

The reclassification of FFPI into four risk levels, namely low, medium, high, and extreme, overlaid with historical flash flood data is shown in Figure 8(a), while the flood extends map area results obtained from the SAR image of Sentinel-1 GRD data is shown in Figure 8(b). The flood occurred in the red area within the yellow circle in Figure 8(b), and upon comparison with the area depicted within the yellow circle in Figure 8(a), it can be inferred that the flood happened in the high-risk area of flash flooding in accordance with its potential. The radar image indicates that the region that was potentially extremely vulnerable to flash flooding did not appear to have been impacted by the said disaster.



(a) (b)

Figure 8: Comparison of Outcomes: (a) Historical Data, (b) Flood Extent
Source: Author's Output

Discussion on Method Used for Study Area

As mentioned earlier, it was noted that in the area that was highly susceptible to flash flooding according to FFPI, flash floods occurred rarely, as expected from the obtained results. This suggests that the outcomes obtained in this section may not accurately reflect the actual situation, where the area is expected to experience extreme flash flooding. To address this, an enhanced and more comprehensive version of FFPI, known as FFPI Weights-Of-Evidence (FFPI WofE), was developed in 2022. It incorporates additional factors such as elevation, aspect, profile curvature, depth of fragmentation, Stream Power Index (SPI), Topographic Wetness Index (TWI), Topographic Position Index (TPI), precipitation, lithology, and Hydrologic Soil Group (HSG). A new WofE equation, which uses deterministic weighted average spatial analysis, was applied, and the resulting output was divided into five FFPI vulnerability classes (Kocsis et al., 2022).

Most previous studies focused on areas within river basins and catchments where natural flash floods occur. This is the primary reason why the results of this study differ, as the study area is located in an urban region where floods are caused mostly by human activities, known as urban flash floods. Man-made structures like drainage systems play a significant role in urban flash floods. The lack of important factors in this study might have affected the results. Precipitation is also a crucial factor to consider since urban flash floods are usually caused by prolonged and heavy rainfall in urban areas, resulting in an increase in stormwater levels.

CONCLUSION

FFPI is a tool used by researchers and policymakers to identify areas that are susceptible to flash floods and can be used to provide information on flood risk reduction aspects for Development Proposal Report (DPR) (Afida et al. 2016). In Malaysia, FFPI has not yet been implemented in any region of the country. This study incorporates four original factors, including slope, soil, vegetation, and landcover, which have been previously used in research conducted around the world. The findings indicate that Scenario 2 yielded the best results and suggest that Shah Alam has a 71% chance of experiencing a high-level flash flood and a 22% chance of experiencing a medium-level flash flood. The FFPI is a model that provides an index ranging from 1 to 10, and given that Shah Alam's FFPI is at 47.5% for an index value of 5, which is the median, it can be classified as being at medium risk for flash floods. While the results are not entirely satisfactory, they do demonstrate the potential of Shah Alam given that the primary factors have been considered. By incorporating an additional factor, such as the one discussed, more reasonable results may be obtained.

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AUSPICIOUS GREEN RETROFIT STRATEGIES IN TWO-STORY TERRACE HOUSES: CASE STUDY OF PETALING JAYA SELANGOR MALAYSIA

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Abstract

The surge of terrace house retrofitting practices has evoked sustainability concerns among the construction players. With the popularised means of upgrading the house condition, green retrofit becomes critical to achieving sustainable retrofitting among the existing residential building. Hence, this study aims to evaluate the potential application of green retrofit strategies in a two-story terrace house. The investigations were made concerning the Petaling Jaya District housing development. This thorough investigation involved analysing the retrofitting behaviour of over 2,946 cases leading to the key building components for applying the green retrofit approach. The outcome of the analysis shows that despite the common practice of retrofitting, the result mostly does not depict the implementation of a green approach in which the majority of upgraded works only reached the second degree – only 30% of improvements involved. The high rate of upgrading actions initiated depicts an immense potential for green retrofit strategies to be administered among the existing residential building stock, taking the measures towards more enforceable roles in pushing the country's low carbon movements forward.

Keywords: Green Retrofit, Terrace House, Existing Building Retrofit, Sustainable Building Development

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INTRODUCTION

As one of the countries with a high urbanisation rate, Malaysia developed a considerable amount of existing building stock. The growth of new construction only accounts for a limited percentage of development due to the dense urban landscape of cities. To begin with, most existing building stock was not built as energy-efficient buildings and calls upon the venture of green retrofit to achieve sustainable development (Jagarajan et al., 2017). The widespread adoption of green development for the past few decades has encouraged sustainable building practices among existing building stock. Besides, according to Masrom et al., (2017), building improvement of the 1960s and 1970s stock has become increasingly significant following their declining performance.

Retrofitting strategy is the current prospect to attain green in existing buildings as it has emanated as one of the key strategies for energy usage and carbon emission reduction. Despite that, the uptake among existing residential buildings remains limited and requires inclusive guidelines for successful implementation (Ramli et al. 2022). As the most popular housing typology, terrace house transformation is not a new norm in the Malaysian construction industry as the approach unlocks the potential for sustainable retrofitting while encouraging the revolutionization of green practices in existing residential buildings. Additionally, studies on Malaysian terrace houses drew more attention today regarding design and thermal comfort. Several studies (Abdul Rashid et al., 2016; Leng et al., 2021) have argued and asserted that the existing terrace houses in Malaysia did not sufficiently build to optimize thermal performance and are suited to the tropical climate context. It has further incited common modifications among this typology.

Hence, the objectives of this paper are (i) to analyse the retrofitting behaviour among the existing two-story terrace houses in Petaling Jaya, and (ii) to investigate the application of green retrofit strategies among the cases. In conclusion, this paper deliberates the application of green retrofit strategies in the upgraded works of two-storey terrace houses to achieve sustainability among existing residential buildings.

LITERATURE REVIEW

Retrofitting in Malaysian Terrace Houses

With about 6.02 million existing residential stock in Malaysia (Valuation and Property Services Department and Ministry of Finance Malaysia, 2022), terrace house is the most popular typology and homeowners are most likely to opt for retrofitting to improve the original condition of their houses. The residential building plays a critical role in promoting sustainability at the community level, considering the commitment can be entirely according to the homeowners' decision-making. Previous studies on Malaysian terrace houses covered a range of topics encompassing behavioural adaptation (Rahim & Hashim, 2012), changes and modifications of the design (Omar et al., 2017), and thermal comfort and performance (Leng et al., 2021; Othman et al., 2021; Tuck et al., 2020).

Green Retrofit Strategies to Achieve Sustainable Building Development

Retrofitting existing buildings presents a great platform for reducing energy consumption towards nearly zero energy levels (Ohene et al., 2022) and is regarded as one of the key strategies for bringing off sustainability to the built environment at a relatively low-cost (Ma et al., 2012). In addition to that, further suggestions for feasible application of green retrofit strategies in terrace house retrofitting are described in Table 1. The below-highlighted strategies are among the most common green improvements that have potential utilization in terrace house retrofitting.

Table 1: Potential retrofit strategies for thermal performance

Elements	Retrofit strategies for thermal performance	References
Internal Wall	Apply phase change materials (PCMs) layer below the internal finishing of the wall	Al-Absi et al. (2021)
External Wall	Repaint with lighter-coloured paints Use of insulation on the vertical wall Use aerated lightweight concrete wall Add effective shading devices like awnings Use light shelves or exterior shelves	Hong et al. (2019) Shukri et al. (2020) Hong et al. (2019) Nadiar & Nusantara (2021) Hong et al. (2019)
Window / Door	Replace double or triple-glazing windows Use low-E glass for insulated window Install reflective tint on the window	Rabani et al. (2017) Hong et al. (2019) Y. Hong et al. (2019)
HVAC	Use new and highly efficient air-conditioners Use heat pumps and evaporative coolers Ensure adequate ventilation measures	Leung (2018) Y. Hong et al. (2019)
Electrical system	Replace lighting with LED fixtures Replace low energy saving lamps T5 fluorescent Use energy-saving motion sensors	Leung (2018) Haq et al. (2013) Leung (2018)
Water & Appliances	Replace water fittings with highly efficient ones Replace energy-efficient water heating system	Leung (2018)
Roof / Skylight	Use high-density polyethene nets as roof covers Use polyurethane insulation on the roof Install rooftop solar PV Install green roof	Tuck et al. (2020) Shukri et al. (2020) Florez & Ghazali (2020) Azis et al. (2021)

Ayodele et al., (2020) assert the key indicators for an effective retrofit strategy include minimization of energy consumption while conserving thermal comfort, upgrading architectural quality, acquiring a controlled impact of carbon emission, and making the expected cost of a retrofit intervention significant. The study further suggests that the building envelope is a critical factor influencing the amount of energy usage in a building. Several elements are forming the building envelope, like walls and thermal mass, roof, and windows. Table 2 presents building elements that contribute to reducing energy consumption in buildings and achieving the optimum thermal performance of terrace houses.

Table 2: Summary of building envelope elements of cases in Malaysian terrace houses.

Elements	Authors	Studies
Wall and Thermal Mass	Othman et al. (2021)	The influence of a higher window-to-wall ratio (WWR) in the living room of a terrace house will result in the lowest thermal comfort level
Roof	Tuck et al. (2020)	Roof cover maintained a consistent surface temperature at roof tiles and reduced the convective heat flux by approximately 70-80% in the attic and 88% in the room. Encourage use of active cooling with a ceiling fan is required to achieve a comfortable indoor temperature
Window	Othman et al. (2021) Leng et al. (2021)	Window placements and shading devices help in reducing sun exposure to the frontage of a building The current Uniform Building By-Law 1984 on a minimum of 10% openings of the total floor area because it does not effectively provide good thermal performance.

Hence, implementing green retrofit strategies during retrofitting works by highlighting the above building elements seems like a critical resort to achieve energy efficiency in residential buildings. This way, the green mandate for the building typology can be secured for sustainable building development. The above summary of studies on Malaysian terrace houses has further signified the urgency of devising a comprehensive green retrofit framework for residential buildings.

RESEARCH METHODOLOGY

This study employs qualitative case study research and observational data from multiple cases of two-storey terrace houses in Petaling Jaya (PJ). The data gathered during the field observation covered four (4) neighbourhoods in PJ, in which the case selection is designated from previous studies on PJ (Ju et al., 2011). Figure 1 below shows the selection of cases based on data collected among intermediate two-storey terrace houses in the city focusing on Section 17, Damansara Jaya (SS22), Kelana Jaya (SS5) and Kota Damansara (Section 6 PJU5). The selection of PJ is based on the previous extensive research suggested study by Ramli et al. (2022) to promote sustainability among residential buildings. The rise of new residential buildings in the city is becoming restricted due to limited land available which further encourages modifications (Ramli & Yunus, 2022). Derived from the objectives formulated, the observational process among 2,946 samples built throughout the 1960s to 1990s in the city was studied and observed.

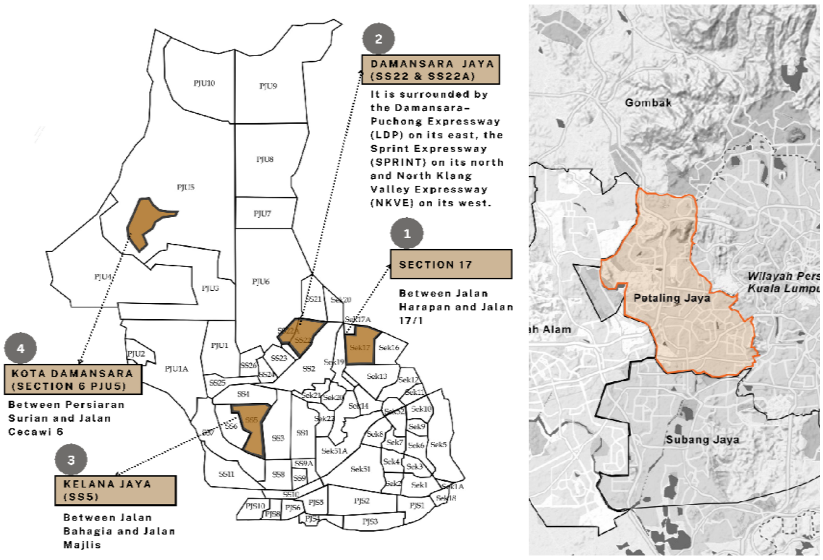
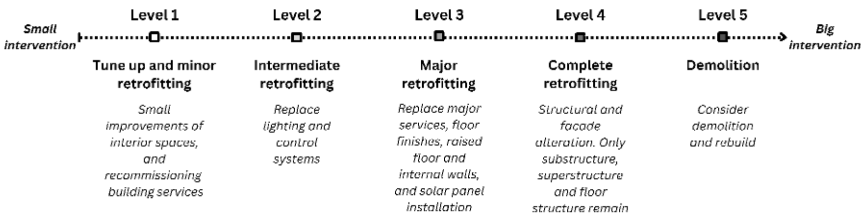


Figure 1: The selection of cases in four different districts of Petaling Jaya

This study utilises a conventional content analysis method in which codes are derived from data. The first part of the data range is a referral from Building and Construction Authority, (2010) should reflect the extent of upgraded works done among the cases as well as actions entailed during each of the designated works (Figure 2). The result will review the state of retrofitting behavioural data and further analyse whether green initiatives were adopted by the residents as well as whether each upgraded work is enough to reflect the drive towards sustainability.

Figure 2: Retrofit level in buildings



Source: Building and Construction Authority, (2010)

Then, the analysis part confers the retrofitting behavioural data with frequency provided within the relevant data. The analysis discloses the conduct of retrofit level among the housing typology and key building components for each level of retrofits to determine the best suitable green retrofit strategies. The cause also presents the retrofitting rate among the cases of two-storey terrace houses in PJ. Consequently, the outcome of this analysis is expected to facilitate the study during the next stage of research in devising the green strategies for each building component that ensued from this remark. Table 3 summarizes key findings of the data collected from PJ observational studies on socio-demographics, housing characteristics, retrofit behavioural and strategies for retrofitting works.

Table 3: Summary of main findings from observational studies.

Observational studies on	Main findings
Socio-demographic characteristics of the case	The characteristics of the cases such as development year, age, population, location and the total number of houses associated with the area
Housing characteristics	Type of the housing (intermediate two-storey terrace house), spatial arrangement of the spaces, building frontage facade of the housing unit as well as materials used
Behavioural characteristics of the retrofitting	The extent of retrofitting done to the cases from Level 1 to Level 5 that covers minor retrofit to complete demolition as well as the houses that remain in the original condition
Strategies of retrofitting	Residents conduct retrofitting differently according to their needs. The majority of retrofitting works were done without considering initiatives toward green

ANALYSIS AND DISCUSSION

From the case study of two-storey terrace houses in the PJ area, the extent of retrofitting works carried out in the area along with the additional information on the cases is included in Table 4. The cases of Section 17, Damansara Jaya, Kelana Jaya (SS5), and Kota Damansara (Section 6 PJU5) are defined as Cases 1, 2, 3, and 4 respectively. The scope of the study is limited to intermediate two-storey terrace houses due to the high numbers of the typology and restricted options for modification. From the cases, it is concluded that the majority of residents have conducted level 1 and 2 retrofitting works in which about 1,132 units had done cosmetic repairs on the building façade. Following that, about 823 units with a major retrofit, and, 535 units conducted complete retrofit. It is a positive note that no cases of demolition were spotted during the observation, as demolition and disposal of the whole original structure to build a total replacement will result in an increased carbon footprint (Building Research Establishment (BRE), 2016).

Table 4: Number of interventions acted among the cases.

Area	Case 1	Case 2	Case 3	Case 4	Total
Year	1965	1975	1984	1992	Between 31 - 58 years old
Household	3072	1932	2536	2683	Total household of 10,223
Total Houses	712	1260	400	574	Selected 2946 units
Original Design	136	141	86	93	456 units remain intact
Levels 1 & 2	301	488	103	240	1,132

Area	Case 1	Case 2	Case 3	Case 4	Total
Level 3	193	421	93	116	823
Level 4	82	210	118	125	535
Level 5	-	-	-	-	No cases observed

Source: Ju et al. (2011) *and Author's Observation*

For the first part of the retrofitting level, it is observed that many of the cases indicate improvements in building services that are – the additional air-conditioning. The upgrade automatically differs the extent of retrofitting between minor (Level 1) and intermediate (Level 2) in which the latter highlights the usage of HVAC among the cases. Major modification project (Level 3) involves works of both minor and intermediate with the replacement of major building services, plus the possible addition of solar panel components. Meanwhile, complete retrofitting manifests major structural changes in the substructure, superstructure, and floor that completely alter the façade of the building.

Apart from that, it is noted that out of 2,946 units surveyed, about 456 units have remained with the original façade of the building without any upgrade works implying that despite the ageing condition of the building, several houses remain unchanged without any improvements. By looking at the trend, and the increasing land price in the cities, the decision for improvements eventually will be made by the homeowners sooner or later.

On top of that, the study also identified several distinct retrofitting behaviours involved in all intervention levels. With a reference to the existing guideline of retrofitting level, this paper came up with a detailed action of several typical modification works of the cases during retrofitting. Table 5 below describes the designated behaviour among the cases of two-storey terrace houses with each of the building components involved in the process identified. In the end, overall remarks on the retrofitting behaviour for each of the cases are incorporated.

Table 5: Analysis of retrofitting behaviours conducted among PJ cases

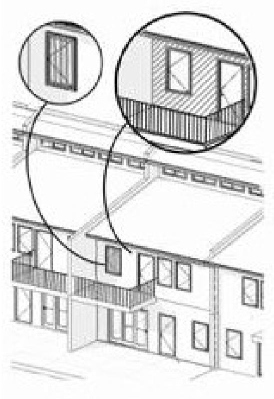
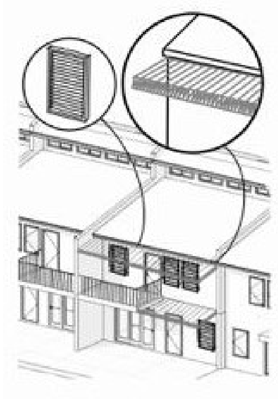
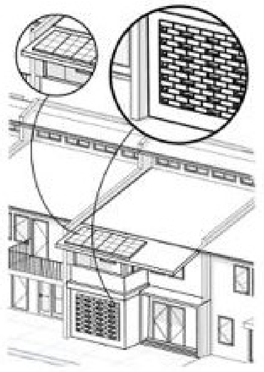
Retrofit	Conventional behaviours in retrofitting	Element	Remarks
Level 1	***Tune Up and Minor Retrofitting***		
	Install modern blinds/use curtain Revise layout to upgrade daylight, flexibility Repaint the interior & exterior of the building Replace energy-saving equipment (washing machine, refrigerator, oven, etc.) Ensure internal equipment is repaired and upgraded	Windows, Walls, Interior	Almost 70% of the cases consist of terrace houses from the year 1960 – 1970
Level 2	***Intermediate Retrofitting***		
	All of the above strategies in Level 1 Replace the old lighting system Install air-conditioning system Replace the automatic gated system Add a tinted/laminated/glazing system to the window	Electrical, Façade, Fence, Windows	

	Add temporary lightweight shading devices		
Level 3	***Major Retrofitting***		
	All of the above strategies in Level 2 Rearrange the interior spaces layout (replace services, floor finishes, raised floor, walls) Expand spaces from the original building Convert the balcony into a new space Install solar control system Add extended structural element (porch)	Façade, Balcony, Walls, Windows Roof	Terrace houses of the 1970s made up 51% of the cases
Level 4	***Complete Retrofitting***		
	All of the above strategies in Level 3 Made major alterations to the existing façade aesthetic and features Add major structural elements that completely change the original facade Possible relocation of stairs Replace roof structure and finishes	Interior, Windows, Walls, Façade, Structural, Roof	About 68% includes 1970 – 1980s terrace houses
Level 5	***Consider demolition and rebuild***		
	Remove all major elements of the building with the remaining structures only	All elements	No cases observed

The current retrofitting behaviour among the two-story terrace houses in PJ shows that a high number of upgraded works commonly conduct improvements from minor repairs to intermediate retrofitting which is insufficient to achieve high energy savings. Among the conventional strategies of retrofitting, despite the same building elements being used, the application of green technologies is not absolute. According to Global Buildings Performance Networks, GBPN (2013), despite the energy renovation of a building can reduce energy consumption by more than 75% in many cases, a standard retrofit work will often achieve energy savings in the range of 20 – 30%, sometimes even less. The most common practices of terrace houses in PJ reflect this phenomenon which can result in energy savings achievement by up to 30%. In the case of the European Union, the country has shifted to placing more critical actions of reducing GHG emissions by targeting 70% of renovations taking place should be deep renovation (that can achieve between 60 – 90% of energy savings) by 2030, while remaining 30% should be medium-depth renovation – estimated at 40 – 60% energy savings (BPIE, 2021). It is to ensure existing building stock can achieve carbon reduction. These findings further extend the immense potential of green retrofit strategies adoption to ensure improvements in the higher energy savings can be accomplished in the future undertaking.

In addition, a study by Ohene et al., (2022) emphasises the use of passive design strategies that are capable of reducing total energy demand by up to 50% in residential buildings. When an additional solar PV system is installed to counterbalance the residual energy needs with a payback period of 6 – 10 years, it will convert the building into Net-Zero Energy Building (NZEB). Following the green strategies highlighted in Table 1, the generic model of the front façade of the terrace house is incorporated to express the designated building components with the extent of retrofitting associated during each level of interventions.

Table 6: The extent of green retrofit strategies on terrace house retrofitting

Level 1 – Minor Retrofit	***Level 2 – Intermediate***	***Level 3 – Major Retrofit***
		
Use blinds; Repaint exterior wall with lighter-coloured paints	Replace tinted Low-E glazing windows; Install shading devices; Use light shelves	Install solar panel; Use perforated double façade; Use insulation for walls

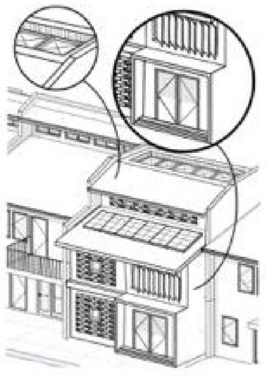
Level 4 – Complete Retrofit	***Level 5 – Demolish and Rebuild***
	
Install all previous strategies and use green roof/ roof cover/ solar PV and ensure adequate ventilation measures at walls, door and windows (passive design)	Conduct complete demolition, completely alter the whole building's appearance, structure and façade

Table 6 illustrates a simplified diagram of green retrofit application in retrofitting, showing the extent of interventions across different levels. The illustration also highlights the importance of promoting green knowledge and understanding among homeowners as carbon emission reduction has the lowest priority when deciding on the building intervention from their perspectives (Kermanshahi et al., 2020). It has further stressed the need to educate homeowners about their deprived awareness of the consideration of sustainability in modifications and how their choices can minimize the impact on the environment. It is eminent that there is ample potential for terrace house retrofitting, and steering the movement toward green seems like a great start to the initiative. It is in line with Roosli et al. (2019) that asserted the need for increased quality and improvements of residential buildings as they play a part in national environmental initiatives.

CONCLUSION

The application of green retrofit strategies in existing buildings has been studied across the world over the last few decades, featuring promising capabilities for the global reduction of energy usage and carbon footprint. However, the implementation in the context of residential buildings is rather limited, looking at the behavioural data of retrofitting trends in PJ. It should be reiterated that despite the popularized modifications conducted among terrace houses, the majority of the intervention level can only be categorized under minor and intermediate retrofit. The outcome of this study pointed out that green improvements among existing residential buildings are crucial as they may be one of the green prospects for making urban cities green and sustainable. Hence, future recommendation suggests comprehensive green retrofit strategies for the building typology to be developed for sustainable retrofitting projects in the tropics.

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COST BENEFIT ANALYSIS (CBA) IN BUILDING INFORMATION MODELLING (BIM) APPLICATION IN GOVERNMENT HEALTHCARE FACILITIES PROJECTS IN MALAYSIA

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Abstract

The healthcare industry in Malaysia is expected to grow to 127 billion ringgit by 2027. This vast investment definitely involved massive construction activities, which subsequently, require an advanced support system, to ensure the deliverable. Integration of CBA and BIM will further enhance the government construction project delivery. The level of BIM adoption in Malaysia's Construction industry is still low due to several obstacles; lack of knowledge of BIM, lack of data on the return on investment of BIM, and implementation cost and benefits. The objective of this paper was to identify the current approach of CBA toward BIM application in Government Healthcare Facilities in Malaysia. A mixed method with a nonprobability sampling technique was adopted. Where, 53 out of 90 respondents of the BIM expert population registered with the Public Works Department (PWD) BIM Centre have replied to the questionnaire. Meanwhile, five (5) semi-structured interview sessions were conducted. The findings have discovered that, awareness of the BIM application in the construction industry is important in this digital era. Nevertheless, the integration of CBA in BIM in Malaysia can be considered still low, compared to other countries such as Singapore and Australia. The integration of CBA in BIM adoption falls under level 3 of BIM Maturity.

Keywords: Building Information Modelling (BIM), Cost Benefit Analysis (CBA), Integration, Level of Adoption

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INTRODUCTION

The construction industry is highly competitive, and all parties must be highly competitive and innovative to remain substantial progress and be successful (Chan et al., 2019). The healthcare industry in Malaysia particularly to be one of the most competitive industries today. The sector is expected to grow to 127 billion ringgit (US$30 billion) by 2027, fuelled by increasing demand for healthcare services from an ageing population, rising affluence, and increasing life expectancy (Medina, 2020). This large public investment in construction requires an advanced support system, to ensure the deliverable and provide a significant impact on national growth. One mostly used framework to support such crucial decisions in public projects and policies is Cost-Benefit Analysis (CBA) (Belay et al., 2016). The construction process for healthcare is more complex with emerging healthcare disruption, ageing infrastructure, and increasing patient demands for better services and facilities. Hence, Building Information Modelling (BIM), the process of creating and managing digital information about a built asset needs to be the standard for building projects, especially in the construction of complex healthcare projects (News Hub Asia, 2019).

Building Information Modelling (BIM) can be claimed as a procedural and technological shift in construction, it can provide betterment in project delivery. The Malaysian Government always provides full support for the implementation of digitalization of the construction sector through the policies outlined in the Construction Industry Transformation Plan (CITP) and via the 12th Malaysian Plan. and Construction 4.0 Strategic Plan (2021-2025). Government agencies such as the Public Works Department BIM unit and Construction Industry Development Board (CIDB) MyBIM Centre actively promote BIM and its benefits to the construction sector, through seminars and various other events. This effort has indirectly increased the level of awareness among players in the Construction industry regarding the benefits of BIM. The use of BIM alone without integrating it with other methods may not have a significant impact on project delivery (Mohd Fateh & Abdul Aziz, 2021). Belay et al. (2016) discovered, that in recent research, most scholars agreed, that it endeavours to embed some of the advanced modelling methods such as BIM and CBA to provide maximized benefits to the project delivery, particularly in cost-saving.

However, the level of adaptation of BIM in the construction sector depends on several barriers. Ullah, et al. (2019) discover among the top barriers facing either developed or developing countries in adopting BIM are (i) high initial cost, (ii) data ownership issues, (iii) interoperability between software programs and (iv) lack of standardized tools and protocols. From another perspective, the integration of BIM and CBA is no exception in facing the barriers, as CBA is more cost-oriented, and most of the parties might consider cost information to be considered confidential.

LITERATURE REVIEW

Building Information Modelling (BIM) and Cost Benefit Analysis (CBA)

The emergence of BIM technology applied in the Architecture, Engineering, Construction, and Operation (AECO) industry acts as a cornerstone in speeding up the completion of the project. (BIM, 2009) as cited in Chen, et al. (2018) interpreted BIM as a multifaceted software data model by visualising an architectural design from virtual and augmented reality technologies through integration of capital and recapitalized installation into the design as a requirement from users. While Autodesk (2021) clarified BIM acts as an "intelligent 3D model-based process" tool for professional practitioners to efficiently plan, design, construct, and manage buildings and infrastructures primarily in the AEC industry. Though, obstacles and challenges may arise if the processes are not applied properly (Chan et al., 2019). Similarly, Liu et al. (2021) referred to BIM as a technological process of using a digital information model in a virtual environment to achieve construction management throughout the life cycle of construction facilities efficiently in the era of Integrated Digital Delivery (IDD). Likewise, Bryde et al. (2013) as cited in Ahmad Latiffi et al. (2016) defined BIM as an innovative way of approaching the design, construction operation, and maintenance of the building. While Brahim (2018) claimed BIM in her research as a methodology that improves the performance of work by allowing construction professionals to manage the construction process throughout the project lifecycles with the use of BIM technology. To summarize, Gerges et al. (2017) as cited in Darwish et al. (2020) concluded BIM can enhance the procedures and technologies in Architecture, Engineering, and Construction (AEC) industry.

Meanwhile, CBA was initially described as a systematic process for decision making by Benjamin Franklin (1772). It was largely invented by Jules Dupuit in the 1840s. The extensive real-world application of CBA started with the US Flood Control Act of 1936, which made CBA mandatory for flood control projects. In 1950, guidelines were published. After 1960, the use of CBA became mandatory in the US, Canada, and the UK for certain policies and projects (Koopmans, C., & Mouter, N.,2020). There are several definitions of CBA discovered by scholars. Cost-benefit analysis is a formal analysis of the impacts of a measure or program, designed to assess whether the advantages (benefits) of the measure or program are greater than its advantages (costs) (European Road Safety Observatory, 2018). However, David (1998) defined CBA as the process of using theory, data, and models to examine trades-off, products, and activities for assessing relevant objectives and an alternative solution to assist decisionmakers in choosing the most appropriate alternatives. From another perspective, Sean, C (2021) defined Cost Benefit Analysis (CBA), as a process or tool to support decision making in projects. CBA evaluates the cost versus the benefit of a project to determine project feasibility (how much the benefit outweighs the cost) as well as provide a decision-making metric when weighing up multiple options.

Level of BIM Adoption in Malaysia Construction

Implementation of BIM around the globe in recent decades forced many nations to transform their construction industry, particularly into digitalization. A report by the World Economic Forum (2018) has highlighted the importance of BIM as a centrepiece of the industry through the application of several technologies. The adoption of BIM throughout the whole construction lifecycle needs a collaborative and integrated platform and support from the industry players. BIM adoption in Malaysia is showing drastic improvement with 49% of industry players currently using BIM compared to 17% in 2016 (CIDB, 2020). This percentage, however, is still far behind the government's ambitions via Construction Industry Transformation Programme (CITP) 2019. Whereas to achieve 70% BIM adoption in private and public building projects above RM 10 million by January 2021 and 100% of all public building projects above RM 100 million (for PWD building projects) using BIM Level 2 by the 4th quarter in 2020. At glance, Malaysia's BIM adoption rate is still low at 49% compared to the UK's 69% in 2019 (BIM Report, CIDB 2020). The significant increase of 288.23% from 2016 to 2019 compared to only an increase of 127.78% for the UK, indicates a better future and prospect of BIM within the Malaysia Construction Industry.

Benefits of Integration CBA and BIM

Integration of CBA and BIM, provides the investors with both transparency of value and an understanding of the risks of complex infrastructure projects (Parker, J., & Parker, J. C., 2014). Furthermore, these tools can define relationships between objects and keep changes consistent and coordinated. So, as the design changes, so can the economic costs, benefits, and risks. BIM can show the economic business case for design alternatives while maintaining constraints such as building codes, design, or safety criteria, and local or community standards.

The integration of CBA and BIM is expected to enhance government construction project delivery. Belay et al. (2016) their research summarized, that, in managing a mega project which involved a longer span of several activities and challenges, one-methods cannot stand alone to make a sound critical decision. A combination of more than one method is necessary and thus needs a holistic, integrated multi-criteria decision-making process. While Hamidi et al. (2014) stated in their research that conducting a cost-benefit analysis for demolition waste management is very crucial, to make sure that their practice brings profit to the companies.

The Significant of Integration of CBA and BIM in Government Healthcare Facilities Projects in Malaysia

The government's ongoing efforts to combat the outbreak of the Covid 19 pandemic which had been spread in early 2020 reflect the importance of health care for a country. The 12th RMK presented by Prime Minister Dato' Sri Ismail Sabri Yaakob, on 27th September 2021, has presented 9 main focuses, with the goal of "Keluarga Malaysia- Prosperous, Inclusive, Sustainable". Among others, the 5th Focus is on government efforts to increase the well-being of Malaysian families (Prime Minister's Office of Malaysia, 2019). Via this focus, the government has identified proactive measures to increase the preparedness of hospitals, to achieve a ratio of 2.06 hospital beds per 1,000 population by 2025, among others: -

i) The government will further develop new health facilities, in addition to the 12 hospitals that are being built nationwide and to be completed during the Twelfth Plan.
ii) Proposed construction of an Institute of Infectious Diseases which will be built in Bandar Enstek, Negeri Sembilan in 2022, and,
iii) Build and upgrade health clinics across the nation, to narrow the gap between urban and rural health facilities.

The government's concern as described above will certainly cost billions of ringgits in development. Therefore, it is significant and relevant for BIM and CBA to integrate, especially for government hospital projects, to ensure the delivery of the project will be more efficient and can be completed with time, quality, and fixed costs. Zhen (2021) stated that the introduction of BIM technology into the health facilities construction management stage, is important because of its visualisation, to minimise design defect, and make the engineering drawings more intuitive and easier to understand. It also can contribute to great cost savings, improve engineering quality and provide data support for future operation and maintenance activities.

BIM has transformed the way that buildings are designed and delivered, particularly when it comes to the construction of highly complex buildings such as healthcare facilities. Yet few healthcare organisations today are harnessing the potential operational improvements that can come from having BIM data at their fingertips. Much of the data needed for operations and maintenance (O&M)

processes already exists in the BIM models turned over following construction or could easily be included in these models with some advance planning. That healthcare lags other industries in its adoption of BIM for operations is particularly surprising since these complex buildings, with their critical missions, potentially stand to gain the most from using this data (Headley, 2016).

RESEARCH METHODOLOGY

A mixed methods approach had been selected to collect the data to obtain the desired information. The mixed methods were conducted through the dissemination of a set of survey forms among the sampling. The justification for the mixed method was to compliments each finding in each method used. While quantitative and qualitative methods each have their merits and demerits, adopting both can provide more representative findings. Survey and interview techniques will be done simultaneously, while the document review, which is also secondary data will be analyzed before the process of preparing questions for the survey and interview. This is to enable the data to be verified during survey activities and interviews. The full flow chart research process is presented in Figure 1.

These questionnaires had been distributed among the BIM Consultant population, who register with PWD BIM Unit, MyBIM CIDB, and also construction professionals who have direct exposure to Construction Projects with BIM Execution. The amount of sampling for this survey is set at 74 numbers of respondents. This is based on the 90 numbers of respondents (populations) registered via the MYBIM Resources Network List (MyBIM CIDB). No proper bodies are being established to provide appropriate registration and member monitoring as, what is being provided by other professionals such as architects, engineers, and quantity surveyors. The target sampling numbers are based on the sample size calculator provided by Raosoft. All research statements will be set according to the Likert Scale, from 1 to 5; whereas 1 (Strongly Disagree), 2 (Slightly Disagree), 3 (Slightly Agree), 4 (Somewhat Agree), and 5 (Strongly Agree). Findings are then transferred into Microsoft Excel software for further analysis. Where the median value was computed to determine the rank of each of the research statements, as outlined within the questionnaire survey. Mean implies average and it is the sum of a set of data divided by the amount of data. Where the mean value was derived from; the Value of Frequency (Σ vf) obtained from the Survey divided by the Maximum Value of Frequency (Σ max of vf). Σ vf = $(1* n) + (2* n) + (3*n) + (4*n) + (4*n) \div \Sigma$ max of vf = (5*N). Whereas N is the Total Number of Respondents, and n was the Sub Value of respondents for each of the selected Likert scales.

Meanwhile, for the structured interview session, five (5) interview sessions were conducted. All the respondents have been specifically (based on their designation, number of BIM project involvement, and also the number of years in the construction) selected from the same sampling as the questionnaire session, who have completed the questionnaire.

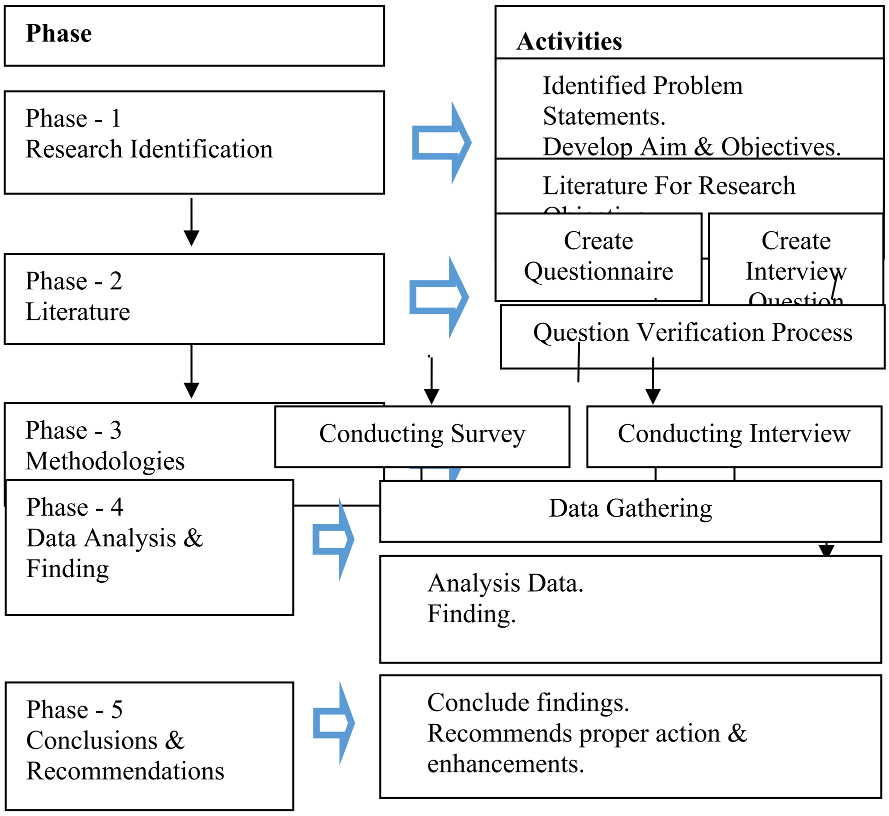

Figure 1: Research methodology flow chart

ANALYSIS AND DISCUSSION

Demography

Data on the demographic background were gained to gather personal information from the samples as stated in Table 1. The highest number of respondents answering the questionnaire experienced ranging from 0 to 5 years and 11-15 years, in the construction industry. However, the number of respondents who have more than 10 years of experience has been the largest sampling population within this analysis, which constituted 66%, this perhaps will translate to a more sensible analysis. There are varieties of professions involved in responding to the questionnaire, and the quantity surveyor recorded the most frequent by almost 44%. This range perhaps provided more opinions from different professional perspectives.

Table 1: Respondents' background for the questionnaire survey

Profession	**No. Of projects handled using bim**	**Experience in the construction industry (years)**					**Frequency (By profession)**
		0-5	**6-10**	**11-15**	**16-20**	**>20**	
Architect	0-4	-	1	-	-	-	4
	5-8	-	-	-	1	-	
	>9	-	-	-	1	1	
Engineer	0-4	2	1	2	1	-	10
	5-8	-	1	-	-	-	
	>9	-	-	1	1	1	
BIM Manager/ Modular	0-4	1	-	1	-	-	8
	5-8	1	-	2	-	-	
	>9	-	-	-	1	2	
Quantity Surveyor	0-4	5	2	5	3	4	23
	5-8	-	-	1	1	-	
	>9	-	-	-	2	-	
Project Manager	0-4	-	-	-	-	-	2
	5-8	-	-	-	-	1	
	>9	-	-	-	-	1	
Others	0-4	4	-	-	-	1	6
	5-8	-	-	1	-	-	
	>9	-	-	-	-	-	
Frequency (Experience)		**13**	**5**	**13**	**11**	**11**	**53**

Demography Background for Semi-Structured Interview

All five (5) respondents are working in the construction industry for years and are involved with numerous BIM projects. Apart from that, the approached respondents come from different sectors in the construction industry three (3) respondents from government agencies Public Work Department (PWD), and two (2) respondents from the private sector with minimum academic qualification of bachelor's degree. Representatives with different backgrounds were chosen to gain varied perspectives and understanding of the topic. A summary of respondents' demographic backgrounds is tabulated in Table 2.

Table 2: Respondents' background for the semi-structured interview session

Respondent	Education	Designation	Years of experience in construction	Number of BIM project involvement
R1	Bachelor (Hons) of Quantity Surveying, UTM Skudai	Quantity Surveying, Grade J41 at Public Work Department (PWD)	21 years	20 ~ 30
R2	Master of Construction Law, (LLM), University of Strathclyde, Scotland	Quantity Surveying, Grade J48 At Public Work Department (PWD)	18 years	5 ~ 10
R3	Bachelor (Hons) of Civil Engineering	Project Director Padang Rengas Construction (PRC) Sdn Bhd	37 years	Only 1
R4	Master of Construction Management, UTM Skudai.	Civil Engineer, Grade J44 at Public Work Department (PWD) BIM Unit	14 years	> 20
R5	Bachelor of Architecture, International Islamic University Malaysia (IIUM).	BIM Modular, at EV Dynamic Berhad	3.5 years	Only 1 Project

Current Approach of CBA To BIM Application in Malaysia Government Healthcare Facilities Projects

As tabulated in table 3, most of the respondents agreed that awareness of the BIM application in the construction industry is important in this digital era with a (4.623) median. Meanwhile, the respondents decided that the organization should not only rely on CBA for considering the project as there are several potential limitations, with a (4.132) median. In addition, several respondents have voiced their own opinion, regarding the current approach level of CBA toward BIM application in Malaysia the data tabulated in table 4.0.

However, the integration of CBA in BIM can be considered still low, compared to other countries such as Singapore and Australia. The integration of CBA in BIM adoption falls under level 3 of BIM Maturity. Where it involved full integration and 6D modelling. The fact is level of BIM maturity in Malaysia is still progressing from level 1 to level 2. This result seems to be parallel with the Malaysia BIM Report 2019 as conducted by CIDB. This can further be supported by other findings concluded by Al-Ashmori, et al. (2020) discovered of BIM approach levels are still low compared to other developing countries.

Table 3: The current approach level of CBA towards BIM application in Malaysian government healthcare facilities projects.

No.	Research statements	Median	Rank
B01	Awareness of BIM applications in the construction industry is important in this digital era.	4.623	1
B04	BIM allows construction professionals to manage the construction process throughout the project lifecycles.	4.509	2
B02	BIM is an advanced tool to enhance the procedure and use of technology in the Architecture, Engineering, and Construction (AEC) industry.	4.472	3
B03	The performance of design, construction operation, and maintenance of the building improved by adopting BIM.	4.453	4
B11	Integration of CBA and BIM offers a baseline for comparing projects by determining which project's benefits are greater than its cost through the best practice of BIM application.	4.396	5
B10	Managing a megaproject needs more than one method, for instance, integration of CBA and BIM, in decision-making, as it is more complex to make a critical decision.	4.377	6
B07	CBA is better at minimizing the risk for the capacity and feasibility of a construction project.	4.358	7
B08	Cost-effective decisions through CBA maximize gains for the construction project.	4.321	8
B13	Integrating CBA and BIM in a complex project, especially in healthcare facilities is efficient and beneficial as it involves many specialities and is complex.	4.321	8
B05	BIM allows construction professionals to manage the construction process throughout the project lifecycles.	4.283	10
B06	It is important to conduct the CBA as it provides a clear view of project viability. to develop strategies for the implementation of the project.	4.208	11
B12	CBA and BIM offer the best approach to achieving the organizational goal while saving on overall construction project investment.	4.208	11
B14	BIM removes extra time consumption which normally leads to extra cost, thus increasing the effectiveness of complex project construction.	4.170	13

B09	The organization should not only rely on CBA for considering the project as there are several potential limitations.	4.132	14

Table 4: The additional opinion on the current approach level of CBA towards BIM application in Malaysian government healthcare facilities projects.

Respondent no.	Additional opinion
R09	Awareness of BIM applications in the construction industry is important in this digital era.
R13	BIM allows construction professionals to manage the construction process throughout the project lifecycles.
R39	BIM is an advanced tool to enhance the procedure and use of technology in the Architecture, Engineering, and Construction (AEC) industry.
R40	The performance of design, construction operation, and maintenance of the building improved by adopting BIM.

All of the respondents have a piece of knowledge and a clear understanding of BIM software applications in the construction industry. According to table 5, generally, all of the respondents shared a similar understanding of BIM as a process, model, and system that integrates all construction disciplines in one program, and effectively assists the smoothness of the project life cycle. According to R3 and R4, BIM is a 3D modelling with parametric information and helps in the construction project's execution in a program. While the majority of the respondents clearly understand the CBA approach toward BIM application by mentioning it as cost, cash flow forecast, and decision making from the project's investment. Besides, R4 also added that the government adopts Creativity Index (C.I) to determine CBA as it is a vital approach to reducing potential additional costs since there is an exact return on investment in terms of monetary value. However, R1 admitted that he is not familiar with CBA, since PWD government agencies obtained a project using the exact budget from the end-user.

Table 5: Respondents' responses current approach level of Cost Benefit Analysis (CBA) towards Building Information Modelling (BIM) applications in Malaysia government healthcare facilities projects.

Respondent	Can you briefly describe your understanding of BIM and CBA?
R1	"*BIM has been implemented at PWD since 2010, in my understanding, BIM is not purely referring to design. It refers to a process in construction project execution, and it involves modelling, CPM, and costing. It supposedly involved all different disciplines architects, engineers, and quantity surveyors. Those processes need to have people software. I'm really not sure about CBA, normally PWD government agencies just procured a project using the exact budget from the end-user".*
R2	*"BIM has what in my understanding and experience, BIM is a tool industry to assist product effective construction products, particularly in design. It helps to provide more efficient design and helps to reduce changes in design during construction. Where clashing was already made earlier and designed to be integrated into the model. While CBA is a tool related to cost, which provided a better decision to the government toward the deliverable of the project and its operation and maintenance".*
R3	*"For BIM as far as I understand, is Modeling for a project, more than making sure all items are done in the program. CBA to me determines from that we have what sort of cost, the pricing, the return on investment, and cash flow forecast".*
R4	*"BIM is a process of developing a 3D model with information and parametric, and it helps in construction project execution, including facilities management. It can also be considered as an approach, "rubbish in rubbish out". While CBA is some sort of study for decision making from any project investment. In government, CBA is meant to reduce potential additional costs since there is exactly return on investment in terms of monetary value, yet the government has Creativity Index (C.I) to determine Cost-Benefit Analysis (CBA)".*
R5	*"BIM is a system which integrates all construction disciplines, during construction activities and the project life cycle as a whole, to ease collaboration and it is a new thing".*

CONCLUSION

In conclusion, most of the respondents are understanding and aware of the BIM tools in the construction industries, contradictory, few respondents were aware of CBA. Furthermore, there is no denying that the current approach of BIM within the Malaysian construction industry was improving. However, the current approach between CBA into BIM application via Malaysia Government Project can be considered low, if compared to other countries such as Singapore and Australia. The integration of CBA in BIM adoption falls under level 3 of BIM Maturity. Where it involved full integration and 6D modelling. The fact is level of BIM maturity in Malaysia is still progressing from level 1 to level 2. There are multiple Critical Success Factors (CSFs) that influence this condition, and it involved the involvement of several stakeholders, and it requires policies, guidelines, finance, human capital, and technologies.

Since the CBA and BIM are the most important tools in the construction and its deliverables. It hopes that the government, via its technical agencies, properly and strictly enforced their current policies, to be followed by all the construction industry players. In addition, more training should be provided, to equip our construction industry professionals with the latest technology regarding CBA and BIM. Since the number of current seats for training available within our industry remains insufficient.

Industry players especially the private sector, contractors, consultants, and developers should have a high awareness of implementing CBA and BIM in Construction. They should not see the initial cost (direct cost) as a burden, but instead see the savings in indirect costs on the cost of operation and maintenance of a building and facilities, as an opportunity.

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DISASTER RESILIENCE RURAL COMMUNITY (DRRC) COMMUNITY CAPITALS: CASE STUDIES IN THE RURAL AREA OF EAST COAST, PENINSULAR MALAYSIA

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Abstract

According to scholars in disaster and resilient-related studies, the focus in building a resilient community in disaster is the need to understand three capitals particularly economic, social, and environmental. This study aims to identify the capitals of internal and external resilience factors for the flood-related disasters experienced by three rural communities in Malaysia. A total of 43 resilience factors were identified from the three key capitals. Field research was carried out to identify the internal and external factors that had contributed to the resilience of the rural communities to floods in Malaysia. Case studies and a questionnaire survey were conducted in the following households: (1) Lubok Setol village in Kelantan state; (2) Teladas village in Terengganu state; and (3) Gajah Mati village in Pahang state. A total of 90 respondents participated in the survey that was carried out from January 2018 (right after the major flood occurred in December 2017) to mid-February 2018. Data analysis was carried out using the Relative Importance Index (RII) method mainly for prioritising and categorising answer key components of community resilience. Responses that received higher RII scores were ranked higher or given a higher priority compared to factors with a lower RII score. Findings indicate that the respondents agreed that all three community capitals strongly influence DRRC.

***Keyword**:* Community Resilience Capitals, Flood, Relative Importance Index (RII), Malaysia

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INTRODUCTION

Resilience community refers to a community that is able to bounce back better by reducing the risk of losses caused by a disaster and recovering in a short period of time (Graveline & Germain, 2022; Hayashi, 2017), thus safeguarding community critical functions and valuable assets. To explore further the state of community resilience, this study seeks to identify the internal and external resilience factors specifically for flood-related disasters experienced by three rural communities in Malaysia. Scholars have noted that Malaysia is highly impacted by floods (Chan, 2012; Mohamed Shaluf & Ahmadun, 2006) rather than landslides, earthquakes, and mudslides, particularly in the rural areas on the east coast of Malaysia. The resilience level of a community, whether strong or weak, can be assessed based on a set of indicators (Cutter, 2020; Cutter, Ash, & Emrich, 2016; Kamarudin, Razak, Ngah, Ibrahim, & Harun, 2015; Sharifi, 2016; Wilson, 2012). In this study, a total of 43 resilience factors were identified from the literature review (economic, social, and environmental capitals) and used to survey the community. Three case study areas were identified, and a total of 90 respondents were interviewed. The main activity of the survey was to rank 43 resilience factors as identified earlier based on the Relative Importance Index (RII) method.

LITERATURE REVIEW

The main concern in building a resilient community in a disaster stemmed from the understanding of economics (Avila-Foucat & Martínez, 2018; Cutter, 2016; Ellis, 1999; Sharifi, 2016; Sherrieb, Norris, & Galea, 2010), social (Aldrich, 2012; Cutter, Emrich, & Burton, 2010; Miller & Rivera, 2011; Sharifi, 2016; Vallance & Carlton, 2015), environmental (Cutter, Ash, & Emrich, 2014; Magill, Wilson, & Okada, 2013; Sharifi, 2016), infrastructure (Cutter et al., 2014; Sharifi, 2016), and institutional (Cutter et al., 2014) capitals. Of these elements, three elements–economic, social, and environmental–have received common agreement from scholars. This finding is in conjunction with the sustainable development theory.

According to Wilson (2011), a community with strong capital (i.e. for all three capitals) would demonstrate a stronger resilience spirit and will be able to bounce back better when a disturbance occurs (Figure 1). Those with well-developed capital will find it easier to recover from a disaster and bounce back.

RESEARCH METHODOLOGY

Identifying Community Resilience on Disaster Factors through Literature Review

A total of 43 factors were identified from the literature review (from the economic, social, and environmental components) and used for a survey of the community. Three case study areas were identified, and a total of 90 respondents were interviewed. The main activity of the survey was to rank 43 resilience factors as identified by the Relative Importance Index (RII) method. Four (4) enumerators were appointed to assist the researcher (principal investigator) during the household survey interview. Respondents were asked to answer on a five-point Likert scale ranging from 1 (*very low importance*) to 5 (*highly important*).

Household Questionnaire Survey

The household survey focused on the factors that contributed to building a resilient community. A total of 90 respondents participated in the survey that was carried out from January 2018 (right after a major flood in December 2017) until mid-February 2018 (Table 1). Sample size calculation was based on population size and a simple random sampling technique. The sample size was calculated using the following formula with a 90% of confidence level or 10% error:

$$\boxed{n = \frac{327}{1 + 327\,(0.1)^2}}$$

n - *sample size*
N - *population size*
e - *level of error*

Source: Kamarudin, 2013; Khailani, 2012; Neuman, 2013 & Author's Calculation (2017)

Table 1: Distribution of sample size of all three case study areas

Village	Number of families	% of each village	Sample size (n=90)
Lubok Setol	131	40	37
Teladas	121	37	32
Gajah Mati	75	23	21
Total	**327**	**100**	**90**

Source: Research fieldwork, 2018

Data Analysis Technique

The Relative Importance Index (RII) technique was adopted for the data analysis. The RII technique has been used widely in construction management research to rank factors contributing to a certain phenomenon, for example, delay factors in construction projects (Muhwezi, Acai, & Otim, 2014; Rooshdi, Majid, Sahamir, & Ismail, 2018), causes and effects of delays in the Malaysian construction industry (Sambasivan & Soon, 2007), and factors influencing project consultants performance (Kamarudin & Samek, 2016; Kometa, Olomolaiye, & Harris, 1994). In the current study, the main intention of using the RII was to prioritise and categorise answers to all 43 key factors for community resilience in all three economic, social, and environmental components. A similar approach was adopted but with slight modification in the examination of factors that contribute to rural community resilience towards a disaster. All the identified factors were examined and ranked based on criticality as perceived by the respondents. The calculation of the RII value was as follows:

$$RII = \frac{\Sigma W}{A*N} \quad (0 \leq RII \leq 1)$$

RII	-	_relative importance index;_
_W_	-	_weight of factor given by the respondents which ranges from 1 to 5 (where 1 represent "strongly disagree" and 5 represent "strongly agree");_
_A_	-	_represent the highest weight (in this case is 5); and_
_N_	-	_represent the total number of respondents_

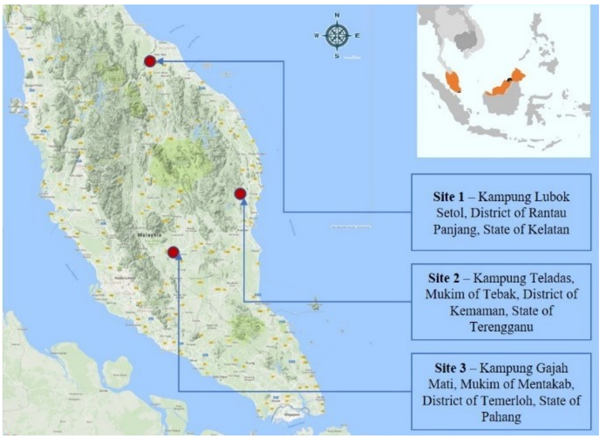
Responses that received a higher RII score were then ranked higher or given a higher priority compared to those with lower RII scores. The RII method enabled the researchers to identify, rank, and formulate a list of relevant factors for community resilience to floods in the case study areas.

Selection of Case Study Areas

Situated in the East Coast regions of Peninsular Malaysia, the case study areas were selected based on five (5) criteria:

- Traditional villages with disaster risk identified in NRPPP 2030 (Criteria 1);
- Village in the East Coast region that had experienced frequent disaster occurrences identified by the Social and Welfare Department (JKM) (Criteria 2);
- Village with established disaster response team sub-committee under the Village Development and Security Committee (JKKK) (Criteria 3);
- Village with Standard Operating Procedure (SOP) being acknowledged by NADMA (Criteria 4); and
- Village that participated in Community Based Disaster Risk Management (CBDRM) Program by MERCY Malaysia (Criteria 5).

Based on all five (5) criteria listed above, three (3) potential villages were identified as fulfilling most of the selection criteria and therefore were selected as the case study areas. The villages are (1) Lubok Setol village in the State of Kelantan; (2) Teladas village in the State of Terengganu; and (3) Gajah Mati village in the State of Pahang. The location and distribution of these villages are shown in Figure 1.



State	Village	Assessment Criteria				
		C1	C2	C3	C4	C5
Kelantan	Lubok Setol	√	√	√	√	NA
Terengganu	Teladas	√	√	√	√	NA
Pahang	Gajah Mati	√	√	√	√	√

Figure 1: Location and Distribution of Selected Case Study Areas based on Selection Criteria
Source: (https://i2.wp.com/investvine.com/wp-content/uploads/ecer_all4.gif, authors, 2017)

FINDINGS AND RESULTS

Analysis of Key Components of DRRC

Analysis of data was organised as follows: (1) calculation and ranking of RII value for all 43 community resilience factors: (2) shortlisting of 10 most important and 10 least important factors to community resilience; and (3) calculation of RII mean value and ranking into three key components of economic, social, and environment.

The RII value ranges from 0 to 1 (0 not inclusive): the higher the RII score, the more important the factor of DRRC. The RII was then ranked as one (1) to forty-three (43) cross capitals (economic, social, and environmental). The results of the analysis are shown in Table 2.

Table 2: Ranking of Resilience Factors based on RII Value/Score Given by the Kampung Lubok Setol (LS), Teladas (T), and Gajah Mati (GM)

Resilience Factors Components	No.	Factors contribute to resilience	Lubok Setol (n=37)		Teladas (n=32)		Gajah Mati (n=21)		TOTAL (n=90)	
			RII	Rank	RII	Rank	RII	Rank	RII	Rank
Economic	1	Economic well-being/advantage	0.7351	43	0.9188	7	0.9333	1	0.9178	1
	2	Diversified income streams/Diversify source of income	0.8486	26	0.8563	41	0.8857	33	0.8600	39
	3	Low dependency on external funds	0.8811	9	0.9125	10	0.9048	14	0.8978	10
	4	Diversified business	0.8649	17	0.8938	27	0.8952	22	0.8822	22
	5	Employment rate	0.8865	6	0.8938	27	0.8762	36	0.8867	15
	6	Job opportunities	0.8973	2	0.8938	27	0.8952	22	0.8956	12
	7	Individual saving	0.9189	1	0.9000	21	0.9143	9	0.9111	2

	8	Community-saving	0.8649	17	0.9125	10	0.9238	3	0.8978	10
	9	Collectively own local resources	0.8162	39	0.8875	34	0.8671	40	0.8511	41
	10	Business continuity plan	0.8270	35	0.9000	21	0.9048	14	0.8711	34
	11	Village insurance and social welfare	0.8703	13	0.9438	1	0.8952	22	0.9022	6
	12	Emergency fund	0.8811	9	0.9063	16	0.9048	14	0.8956	12
	13	Inward investment	0.8162	39	0.8813	40	0.8286	42	0.8422	42
	14	Connection with regional economy	0.8054	42	0.8563	41	0.8286	42	0.8289	43
Social	1	Close interaction between people	0.8811	9	0.9250	4	0.9333	1	0.9089	3
	2	Ability o rely on neighbours at times of crisis	0.8919	3	0.9125	10	0.9143	9	0.9044	5
	3	Availability of skills training and education	0.8541	22	0.9063	16	0.8952	22	0.8822	22
	4	Good health and sanitation	0.8541	22	0.9125	10	0.8952	22	0.8844	19
	5	Availability of multiple services	0.8378	32	0.9000	21	0.8857	33	0.8711	34
	6	Low level of corruption	0.8496	26	0.9313	2	0.8762	36	0.8844	19
	7	Good communication between stakeholder groups	0.8919	3	0.9188	7	0.8952	22	0.9022	6
	8	Female empowerment/empowerment of ethnic/religious minorities	0.8270	35	0.9000	21	0.9238	3	0.8756	30
	9	Open-minded community	0.8486	26	0.9125	10	0.8952	22	0.8822	22
	10	Good and transparent land ownership regulations	0.8649	17	0.8875	34	0.9048	14	0.8822	22
	11	Stakeholders in control of development trajectories	0.8270	35	0.9250	4	0.8952	22	0.8778	27
	12	Strong governance structure at multiple geographical scales	0.8486	26	0.9313	2	0.9143	9	0.8933	14
	13	Community bond, social support, and social institutions	0.8865	6	0.9250	4	0.8952	22	0.9022	6
	14	Safety and security	0.8703	13	0.8938	27	0.9048	14	0.8867	15
Environmental/Physical/ Infrastructure/ Institution	1	High levels of biodiversity	0.8865	6	0.9063	16	0.9238	3	0.9022	6
	2	Good water quality and availability	0.8541	22	0.8875	34	0.9048	14	0.8778	27
	3	Sustainable soil management	0.8432	30	0.9000	21	0.8952	22	0.8756	30
	4	Predictable agricultural yields	0.8595	20	0.9000	21	0.8857	33	0.8800	26
	5	Localized energy supplies	0.8108	41	0.8938	27	0.8667	38	0.8533	40
	6	Multifunctional resources	0.8270	35	0.9063	16	0.9048	14	0.8733	33
	7	Infrastructure robustness and redundancy	0.8378	32	0.8938	27	0.8667	38	0.8644	37
	8	ICT infrastructure	0.8541	22	0.9188	7	0.9048	14	0.8844	19
	9	Inclusive and multimodal transportation networks and facilities	0.8703	13	0.8938	27	0.9143	9	0.8867	15
	10	Land use planning and urban design	0.8703	13	0.8375	43	0.9143	9	0.8689	36
	11	Leadership and participation	0.8378	32	0.8875	34	0.9238	3	0.8756	30
	12	Contingency, emergency and recovery planning	0.8919	3	0.9125	10	0.9238	3	0.8778	27
	13	Equity and diversity	0.8595	20	0.8875	34	0.8952	22	0.9067	4
	14	Research and development	0.8432	30	0.8875	34	0.8571	40	0.8622	38
	15	Regulation and training	0.8811	9	0.9063	16	0.9238	3	0.8867	15

Source: Research fieldwork, 2018

Based on the RII scores and ranks of community capital indicators as shown in Table 2, the ten (10) factors deemed most important in building DRRC were then extracted and presented in Table 3. Social capital contributes five (5) indicators to the below-ten (10) ranking, namely *close interaction among people* (rank 3), *leadership and participation* (rank 6), and *communication between stakeholder groups* (rank 6). While the following four (4) economic capital indicators rank below eleven (11): *household income* (rank 1), *individual saving* (rank 2), disaster insurance (rank 6), and *aid recipient from government agencies and NGO* and *community funds* (rank 10). The remaining one indicator ranks eleventh (11) in the environmental/physical capital, which is *equity and diversity* (rank 5).

Based on the ranking of the 10 most influential factors in DRRC community capitals (rank 1 to 10), five (5) indicators are from social capital, followed by four indicators from economic capital, and only one (1) indicator from environmental/physical capitals (Table 3). This finding indicates that social capital is viewed as having a strong influence on DRRC, followed by four (4) economic capitals, whereas one (1) environmental capital was given lesser consideration by the respondents in building DRRC. The rural communities are small-scale in nature, thus making them closer to each other. These communities are therefore viewed by the researcher as a close-knit set of people. The close interaction among the people has contributed to DRRC as the villagers know each other well. They are able to respond to each other when a flood occurs. Therefore, social capitals were viewed by the respondents as vital in building DRRC. Economic capital is also considered a strong factor contributing to the DRRC.

According to Keerthiratne and Tol (2018), high incidents of poverty may increase a community's vulnerability towards a disaster. Based on the disaster resilience model, a higher vulnerability indicates a lower/weaker community resilience. The rural community is often associated with poverty and a lack of infrastructure, which hinder progress towards development, particularly when dealing with the recovery of damaged properties due to disasters. Therefore, the respondents opined that economic capitals such as household income are sufficient to save for the monsoon season, while disaster insurance could assist them in better recovery from a disaster. The finding indicates that although currently, the respondents are highly dependent on the aid provided by the government and NGOs for recovery, it is their goal to reduce the dependency and reinforce self-help and mutual assistance among the community members. To strengthen their economic capitals, the "equity and diversity" (environmental/physical indicator) of access and opportunities to the resources are essential.

Table 3: Most Important Factors Contributing to DRRC as Rated by the Respondents

No.	10 Most Important Factors	Key Component	RII	Rank
1	Household income	Economic	0.9178	1
2	Individual saving	Economic	0.9111	2
3	Close interaction among people	Social/Cultural	0.9089	3
4	Equity and diversity	Social/Cultural	0.9067	4
5	Neighbours are reliable in times of crisis	Social/Cultural	0.9044	5
6	Disaster insurance	Economic	0.9022	6
7	Communication between stakeholders group	Social/Cultural	0.9022	6
8	Community support system and social institution	Social/Cultural	0.9022	6
9	Leadership and participation	Social	0.9022	6
10	Aid recipients from the government and NGO	Economic	0.8978	10
11	Community fund	Economic	0.8978	10

Source: Research fieldwork, 2018

Meanwhile, the ten (10) least important factors contributing to the resilience of rural communities towards flood are listed in Table 4. However, it is worth mentioning the very small differences in the RII scores between these factors (i.e. with only $\pm$ 0.05 difference). The difference is also considered marginal compared to the 11 most important factors listed in Table 3. Despite a small gap in the RII value score, at least from the researcher's point of view, these 10 least important factors could be included in the discussions of the result and the later phase of implementation in this study. The least important factors in building DRRC as identified by respondents are five (5) in economic capitals, four (4) from environmental/physical capitals, and one (1) from social capitals. The "connection with regional economic" and "inward investment" are given less consideration due to the respondents focusing on local issues and needs. Local resources are still at an optimum level and therefore do not require planning for DRRC. "Diversification of income stream/source of income" is hindered by the limited job opportunities, particularly in non-farm activities. "Business continuity plan" is also given less consideration due to minimal impact on local businesses (domestic DRR measures also applied by local businesses owner). While for environmental/physical capital, the "predictable agricultural yield" is given less priority due to the nature of agricultural yield in the case-study villages, which indeed, are impacted by the monsoon season. "Accessibility to local services" is the only indicator in social capitals listed in the least important factors. This factor could be due to the satisfaction of the availability of multiple services in the village, thus requiring no further enhancement.

Table 4: Least Important Factors Contributing to DRRC as Rated by the Respondents

No.	10 Least Important Factors	Key Component	RII	Rank
1	Connection with regional economy	Economic	0.8289	43
2	Inward investment	Economic	0.8422	42
3	Community own resources	Economic	0.8511	41
4	Predictable agricultural yields	Environmental/Physical	0.8533	40
5	Diversified income streams/sources of income	Economic	0.8600	39
6	Research and development	Environmental/ Physical	0.8622	38
7	Multifunctional environmental resources	Environmental/ Physical	0.8644	37
8	Inclusive and multifunctional transportation networks and facilities	Environmental/ Physical	0.8689	36
9	Business continuity plan	Economic	0.8711	34
10	Accessibility to local services	Social	0.8711	34

Source: Research fieldwork, 2018

The RII score was used to calculate the RII mean values to rank community capital based on economic, social, and environmental components. The calculation of the values and ranking of all the DRRC components (economic, social and environmental) are presented in Table 5. The mean value score for social/cultural is 0.8884; economic capital is 0.8814; and environmental/physical is 0.8773. The mean value score for all three community capitals of economic, social/cultural, and environmental/physical are not significant (differences in mean value score > 0.8). This result indicates that the respondents agreed that all three community capitals would strongly influence DRRC.

Table 5: Mean Value of RII and ranking of resilience key components of Kampung Lubok Setol

Resilience components	RII	Rank
Social	0.8595	1
Environmental	0.8533	2
Economic	0.8510	3

Source: Research fieldwork, 2018

CONCLUSION AND RECOMMENDATION

Building resilient rural communities towards flood in Malaysia will enable them to bounce back better by reducing the risk of loss caused by the disaster in the community, and recovery in a short period of time (Hayashi, 2017), thus safeguarding the community’s fortune. As suggested by Wilson (2012), a community with strong capital (for all three capitals) would presumably show a stronger resilience spirit and will be able to bounce back better when a disturbance occurs. Based on the field research and results presented in Tables 2 to 4, it is crucial for building a strong resilience rural community towards flood in Malaysia to consider the adoption of the 10 most important factors in the DRR strategies (Figure 3).

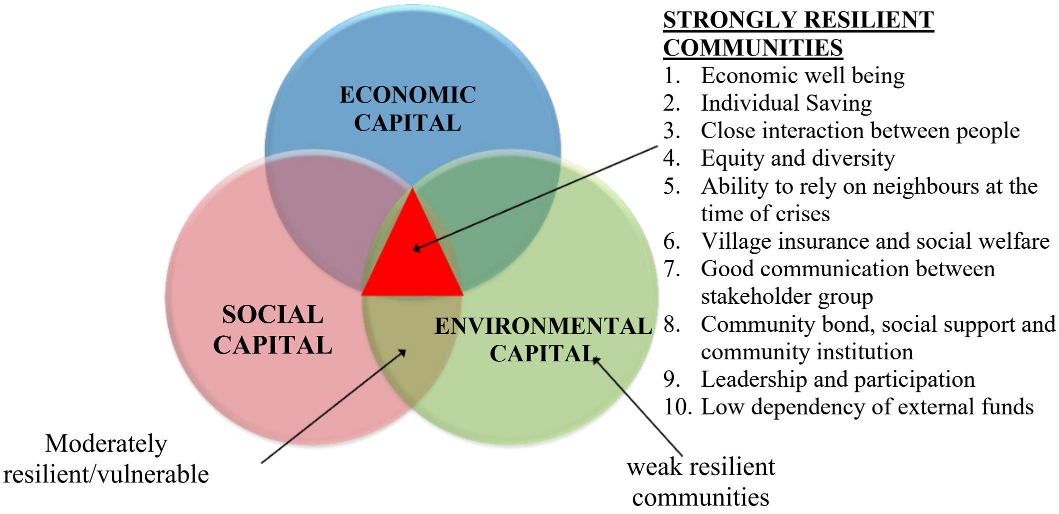


Figure 2: Community Resilience Capital for All Three Case Study Areas.
Source:(Miller & Rivera, 2011, authors, 2018)

The findings of this study may advance the existing knowledge of community resilience, particularly in Malaysia as a developing country (Omar Chong & Kamarudin, 2018). The methodology of the study and the effective use of RII may benefit future research projects on disaster-resilient rural communities. The ranking of resilience factors may also assist the community and agencies involved in implementing building community resilience programmes in the short and long terms.

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EXAMINING CORRUPTION ISSUES IN MALAYSIA CONSTRUCTION INDUSTRY: PARTAKER PERSPECTIVES

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Abstract

Unethical issues in relation to corruption is believed to slowly penetrate into the construction sector around the world due to its involvement with a multitude of players, different phases of work, and a great deal of input from both the public and private sectors. Due to the construction's central role in development, corruption in construction can be harmful to the entire project mainly in terms of poor quality of the finished product, reduced economic return to investments, and increased number of injury and death. Despite concerns on this regard have been discussed, a commitment to rooting out corruption is crucial and is still unexplored. This paper aims to examine the homogeneity levels of perception between project stakeholders on the issues of corruption. A questionnaire survey was conducted with a total response of 37.6% was attained from the total of 189 questionnaires sent to the Government, public authorities, consultants, and contractors. The result indicates that there is a difference in perception between the different groups of respondents in the vulnerable areas of corruption in the construction project development. The outcome could be useful and pave a way for the policy maker in reforming anti-corruption strategies in order to mitigate corruption issues among construction industry players.

Keywords: Corruption, Construction Industry, Transparency, MANOVA

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INTRODUCTION

The construction industry plays a significant role in the socio-economic development of any nation (Grace & John, 2016; Mac-Barango, 2018). The construction industry is associated with the growth of the economy and essentially supports the Malaysia's Gross Domestic Product (GDP) (Khan, Liew, & Ghazali, 2014; Sohail et al., 2016) as more than 120 industries rely on the construction industry (CIDB Malaysia, 2016). In relation to that, RM138 billion investment on the construction sector had been announced in the Tenth Malaysia Plan (2011-2015) by the Ministry of Works with the hopes to grow Malaysia's economy further (Yong & Mustaffa, 2012). In the subsequent plan, the Eleventh Malaysia Plan (2016-2020), RM260 billion was injected for the construction industry (Aris, 2017). From these investments, the construction industry successfully contributed to 4 percent of the Malaysia GDP and was expected to increase by 5.5 percent in 2020 (CIDB Malaysia, 2016). Positive interaction between project actors directed by the elements of trust, stakeholder management, empowerment, and collective decision making, would create value for the project (Latiff, et al., 2020).

Corruption is a fiduciary crime that is believed to slowly penetrate the construction sectors in countries around the world (Rahim, 2010). The construction industry is said to be vulnerable to corruption due to its large size and fragmented nature of construction projects, where contractors and subcontractors are often involved in complex construction activities, extended periods of construction, complicated process and financial intensity (Deyong & Ferguson, 2017; Dosumu, 2018). Nordin (2015) highlighted that construction projects have several phases which are strategy formulation, procurement, construction, and completion, and corrupt practices are spread throughout these phases. Besides, these phases involve a multitude of players (i.e., client, consultant engineers and architects, financiers, insurers, main contractors and subcontractors), different phases of work, and a great deal of input from both the public and the private sectors (Abdul-Rahman, et al., 2010; Kenny, 2009).

According to the Transparency International-Malaysia, the country loses about RM 30 billion each year to corrupt practices (PEMANDU, 2012). Corrupt practices can be found at every phase of a construction projects i.e., in the planning stage, the awarding of construction contracts as well as the operation and maintenance of projects (Murray & Meghji, 2009; Krishnan, 2009; Sohail & Cavill, 2006; Zou, 2006). Furthermore, there is growing consensus within and outside the construction industry that corruption and other unethical practices are endemic in the construction industry (Ameh & Odusami, 2010). Other than that, TI's BPI 2005 also revealed corruption to be greater in construction than any other economy sector as TI's BPI 2008 revealed that public works and construction were perceived to be the most corrupt industry in the world (Krishnan, 2009).

Due to the construction's central role in development, corruption in construction can be especially harmful. In particular, corruption that leads to poor quality of the finished product, and insufficient maintenance can significantly reduce the economic return to investments and carry high human costs in terms of injury and death (Kenny, 2007). The probable reasons could be construction project developments involve numerous parties, various processes, different phases of work, and a great deal of input from both the public and private sectors (Takim & Akintoye, 2002). Besides, there are various ways for corrupt transactions to be carried out; it can range from the demand for sexual favours, to the offer of a contract to a family member, to the promise of political support from powerful interest groups (Transparency-International(a), 2011).

With bribery seen as widespread in the construction sector, stakeholders and organisations should be cautious of bribe paying and not tolerate unethical practices. However, the field of corruption in public sector construction has remained a relatively under-researched area (Tabish & Jha, 2012). Among the many challenges faced by the public service institutions, corruption remains one of the most pervasive and least confronted (Davis & Stark, 2001). In such instances, independent civil society organisations that monitor the deals between government and companies can play an important role in increasing transparency and accountability, and reducing bribery and corruption risks (Hardoon & Heinrich, 2011). Thus, a commitment to rooting out corruption is a critical part of any developmental strategy.

LITERATURE REVIEW

Corruption in Construction Industry

Corruption and bribery are complex transactions that involve both someone who offers a benefit; often a bribe, and someone who accepts, as well as a variety of specialists or intermediaries to facilitate the transaction (Riano & Hodess, 2008). Corruption is usually defined as the misuse of entrusted power for private gain (Transparency-International, 2011). However, Malaysian Anti-Corruption Commission (MACC) looks into corruption as gratification given by any person and received by public officials in relation to official government duties (Malaysia-Government, 2009).

Corruption exists with all different stakeholders and in every phase of project life cycle, including conception; design; bid and contract signing; construction stages (including materials purchasing); commissioning and handover; and operation and maintenance (Murray & Meghji, 2009; Sohail & Cavill, 2006; Zou, 2006; Tabish & Jha, 2012). Nonetheless, most of the issues in corruption is focused at the procurement phase of a construction project development. There are several publications (Ismail et al., 2017; Lane, 2017; OECD, 2016; Transparency International, 2018) that emphasised the procurement phase to ethical and corruption issues. This may be due to complex public procurement procedures and lack of transparency in many countries, and that manipulation is hard to detect (Kuhn & Sherman, 2014).

There are many sources contributing to corruption in construction that can be divided into two distinct factions that are technical and behavioural. Temptation for corruption exists everywhere because an ‘inclination’ for corruption is conceived to be intrinsic to human nature but needs permissiveness, opportunities, and incentives (Gebel, 2012). In the context of Malaysian scenario, the Malaysian Anti-Corruption Commission for the duration of ten years (1998-2008) clearly stated that corruption does exist in the nation’s construction industry. Complexity of construction, weakness in construction management, financial pressure in generating wealth and stringent work process is believed to be the technical sources of corruption (Rahim, 2010). Other than that, construction projects involve a multitude of players that lead to various psychological human behaviour which could affect the attitude towards corrupt activities. Individuals come to consider corruption to be a normal or even acceptable, which has been in place since time immemorial. When norms such as ‘return a favour when asked’ or ‘minimise conflict with fellow members of your community’ exist in a pervasively corrupt society, they could encourage further corruption and further promote social ostracism to those who attempt to fight it (Varese, 2000).

Corruption in the global economy is a fact, with numerous reports that verify corruption in public sector and construction as extremely nasty (Krishnan, 2009). Despite the true cause of corruption is uncertain, it is estimated that the industry’s loss to corruption is approximately 10% or $500 billion per year (Jong, et al., 2009). As for Malaysia, the issue of corruption in construction is at a serious level (Zain, 2014). Given the intrinsically secretive nature of corrupt activities, collecting reliable quantitative information is virtually impossible. But in reality, both the extent and nature of corruption can be measured and assessed with some degree of confidence (Kaufmann, 1998). Due to the fact that corruption is correspondingly more complex to measure and quantify empirically, a number of key international experts refer to the perception of corruption as a suitable measure (PEMANDU, 2011).

Undoubtedly, corrupt practices have a lot of adverse effects to the industry, to the development of the economy, and to human resources. Corruption is said to inflate the cost of construction works by 10 percent (Manaf, 2013), cause devastating effects on the quality of the built environment (Takim, Shaari, & Nordin, 2013), and adjusting to favourable terms in the procurement consumes time and cause delays. Other than the three indicators, corruption has an effect on health and safety when low quality engineering projects fails to meet the safety requirement due to fraud in the workmanship (Folorunso & Aribisala, 2017).

In recent years, corruption control strategy has been high on the agenda in many parts of the world with explosions in studies of the issue but relatively little examine the problem in a sector specific approach (Batory, 2012) (Estache & Wren-Lewis, 2010). To combat corruption in the construction industry, all stakeholders (i.e. company shareholders, professional trade bodies, civil society organisations) have roles to play in exposing and combating malpractice (Transparency International, 2019). However, it has been a long time since the construction industry collaborated for a strategy to attack the problem of corruption (Jong, et al., 2009). Despite some governments had enacted legislation to outlaw bribery, the enforcement has been spotty. Evidence shows that despite government campaigns and initiatives, corruption remains acute, widespread, and in fact worsened in recent years (Siddique, 2010).

Fighting corruption is seen as important to achieveSustainability Development Goals (SDGs) as sustainability is impossible to be achieved with corruption lying within the whole process (Andreevska, 2018). The strategies to combat corruption in construction are raising awareness, strengthening professional institutions, prevention of corruption as well as enforcement and monitoring measures (Nordin, 2015). As for Malaysia, Code of Ethics for Contractors is formulated, created, and implemented by the Construction Industry Development Board (CIDB) with one of the objectives is to outline best practices as well as noble conduct which are accepted as standard practices among contractors that are capable of motivating and enhancing the level of professionalism, integrity, and accountability (CIDB, 2010).

Conceptual framework and hypothesis

Based on the discussion, Figure 1 proposes a conceptual framework consisting of four major parts: National Agenda; Corruption and Construction; Response Mechanism; and Outcomes, which are based on understanding of issues related to corruption in construction across project development.

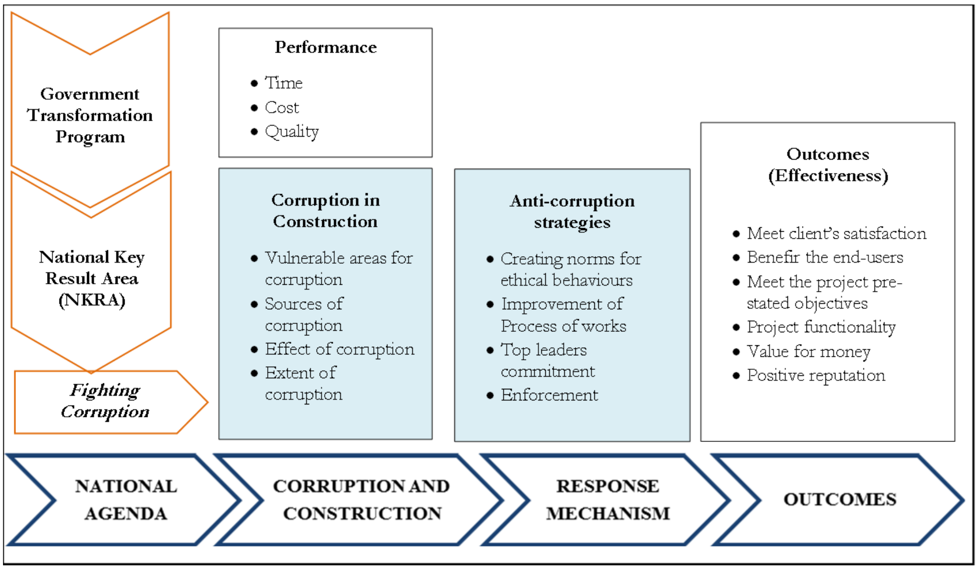

Figure 1: Conceptual Framework

The first part of the framework is the National Agenda, which is the push factor for the research. Fighting corruption is one out of the seven National Key Results Area (NKRA) of Malaysia. Its aim is to improve Malaysia's Transparency International (TI) and Corruption Perception Index (CPI) (PEMANDU, 2012) (Kaufmann, 1998). Furthermore, the National Key Results Area (NKRA) of Malaysia is under the Government Transformation Program (GTP) that is designed to provide all Malaysians access to improved public services irrespective of race, religion, and region. The objective of GTP is to transform the government into becoming more effective in its delivery of services and to move Malaysia forward to become an advanced and united country, with high standards of living.

The second part of the framework is the Corruption and Construction consisting of two components (i.e., performance and corruption in construction). The first component is the performance of the project (i.e., Time, Cost and Quality). Performance or overall success is discussed based on the project's time, cost, and quality performance (Ling & Leong, 2012). In order to plan and manage a successful project, the three parameters of time, cost, and quality should be considered (Bowen & Cattel, 2012). Based on various research, higher corruption leads to poor performance of construction projects in terms of time, cost, and quality (Sohail & Cavill, 2006; Kenny, 2007; Transparency-International, 2011). In addition, other serious consequences of corruption may include lower economic growth rate, ineffective government, infringement of civil/political rights, decrease in investment of foreign and domestic investors, lower quality of public infrastructure, and reduced effectiveness of provision of public goods (Nordin, 2015). In order to come up with an anti-corruption effort, the issues concerning corruption need to be taken into consideration.

Due to the fact that corrupt practices negatively affect the performance of construction industry, the second component focuses on the issues concerning corruption in construction, by which focuses on four (4) elements of vulnerable areas of corruption across the project phases; sources of corruption (i.e., technical and behavioural); extent of corruption; and effects of corruption. Corruption practices can be found at every phase in a construction project (i.e., planning, inspection, design, bid and contract signing, construction, service delivery, and operation and maintenance) (Sohail & Cavill, 2006). As for this research, opportunities for corrupt acts across project phases can be divided into four areas of strategy formulation, procurement, construction and completion.

Furthermore, corruption may root from both technical (in terms of insufficient regulation and effectiveness) and behavioural (due to involvement of multitude of players with various psychological human behaviours). Corruption might be an acceptable and normal means of obtaining routine low-level actions and/or approvals by officials through cutting red tapes in order to make decision-making predictable, motivating underpaid workers, and enabling personnel to obtain political power. Due to construction projects are important for the country's development which involve various processes, different phases of work, and a great deal of inputs from both the public and private sectors, it is not surprising that the incidence of corruption in the construction is high (Abdul-Rahman, et al., 2010) (Kenny, 2009). Extent of corruption relates to the seriousness of occurrence or opportunities for corrupt action to happen. Across the globe, perception of corruption is measured in various ways however, the corruption measurement tools governed by Transparency International are Corruption Perception Index (CPI), Bribe Payers Survey (BPI), and Global Corruption Barometer (GCB) (Riano & Hodess, 2008).

The third part is the Response Mechanism in terms of Anti-corruption Strategies. Based on the literature, various anti-corruption strategies are available across countries and sectors. The strategies include creating norms for ethical behaviours (i.e., Code of Conduct, Whistle-blowing protection, Anti-corruption Policy, Ethical Practices, Administrative Reforms, and Integrity System); Improvement of Process of Works (i.e., Investigation, Prevention, Education, Awareness Raising, Anti-Corruption Agency, Integrity Pacts (IP), and Good Governance); Top Leaders' Commitment, and Enforcement.

Finally, *the fourth part* of the framework is the outcome in terms of project effectiveness as a result from the transparency initiative. It is important to consider the project effectiveness including meeting client satisfaction; benefit the end-users; meeting project pre-stated objectives; project functionality; value for money; and positive reputation.

For the purpose of this study, the second part (corruption in construction) and the third part (anti-corruption strategies) will be given attention and to be tested for difference in opinion based on the research hypothesis:

***H_{01}**: There is no significant difference between the three groups of respondents (i.e., Government agencies, contractors, and consultants) in perception of the issues of corruption (i.e., areas of corruption, sources of corruption, effects of corruption, extent of corruption and anti-corruption strategies).*

RESEARCH METHODOLOGY

The data collection method used for this study is a questionnaire survey with a-ten-point Likert type scaled items for the participants to indicate their level of agreement and disagreement. A non-probability of judgement purposive sampling was used based on the expertise of respondents (Government, public authorities, consultants, and contractors) on the subject matters. The data were analysed using Multivariate Analysis of Variance (MANOVA) from Statistical Package for Social Science (SPSS) version 21.

Based on Table 1, a total response of 37.6% was attained from the total of 189 questionnaire sent. The response rates for the data collection are acceptable since the normal response rate in construction environment is around 20 to 30 percent (Takim & Akintoye, 2002).

Table 1: Response data

Respondents	Sent	Return	Percentage (%)	Cumulative Percentage
Government Agencies	99	25	35.2	35.2
Contractors	43	25	35.2	70.4
Consultants	47	21	29.6	100.0
Total	**189**	**71**	**100.0**	

Other than that, based on the experience of the participants (Table 2), it is reasonable to infer that the majority of the participants have sound knowledge on the issue of corruption in construction with a total of 42 respondents (59.2%) having more than ten years of experience in construction industry or in the effort to fight corruption. This implies that the data gathered is relevant as more than half of the respondents have experience of more than ten years in handling construction projects and/or involved in the anti-corruption effort by which can be considered as highly experienced (Masrom, 2012).

Table 2: Respondents' experiences

Years of experience	**0 - 10**	**11 - 20**	**21 - 30**	**More than 30**	**Total**
Contractor	8	12	4	1	25
Government agencies	16	3	5	1	25
Consultant	5	8	6	2	21
Total	**29**	**23**	**15**	**4**	**71**
Percent	40.8	32.4	21.1	5.6	100
Cumulative percent	**40.8**	**73.4**	**94.4**	**100**	

DATA ANALYSIS

MANOVA tests mean differences among groups across several dependent variables and simultaneously by using sum of squares and cross-product matrices (Sekaran, 2003).

In order to test the research hypotheses using MANOVA, the steps that need to be conducted is summarised in Figure 2:

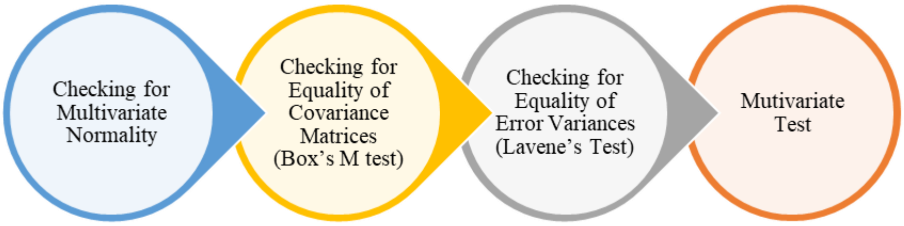

Figure 2: Process for data analysis of MANOVA

Checking for Multivariate Normality

Table 3 shows the result for checking the Mahalanobis Distance to test for the multivariate normality. In the row labelled Mahal. Distance, the value under the column marked Maximum will be used to compare the critical value. In this case, the value is 29.990. The critical value is determined using a chi-square table with the number of dependent variables as the degree of freedom (df) as shown in Table 4. In this case, the dependent variables are five (df=5), hence the critical value is 20.52.

Table 3: Residuals Statistics[a]

	Minimum	**Maximum**	**Mean**	**Std. Deviation**	**N**
Predicted Value	7.4870	22.7123	14.6338	3.18591	71
Std. Predicted Value	-2.243	2.536	.000	1.000	71
Standard Error of Predicted Value	1.891	8.843	3.653	1.268	71

Adjusted Predicted Value	6.8849	27.6074	14.8766	3.86089	71
Residual	-20.71323	22.77507	.00000	12.86089	71
Std. Residual	-1.558	1.713	.000	.964	71
Stud. Residual	-1.707	1.768	-.008	1.007	71
Deleted Residual	-24.85455	24.24376	-.24276	14.06561	71
Stud. Deleted Residual	-1.733	1.798	-.005	1.013	71
Mahal. Distance	.430	29.990	4.930	4.954	71
Cook's Distance	.000	.249	.017	.034	71
Centered Leverage Value	.006	.428	.070	.071	71

[a] Dependent Variable: Organisations

Table 4: Critical values for evaluating Mahalanobis distance values.

No. of dependent variables	Critical Value	No. of dependent variables	Critical Value
2	13.82	**5**	**20.52**
3	16.27	6	22.46
4	18.47	7	24.32

Source: Pallant, 2010

From the result, Maximum Mahal. Distance of 29.990 is larger than the critical value of 20.52 which means that there is a multivariate outlier in the data file. However, based on the data file there are two persons (ID=pbtM03 and ID=c4Ssite) who exceeded the critical value with the largest value is 29.990. Since there are only two persons exceeding the critical value and the sample size is small, these persons will remain in the data file and 'cleaning the data' is not required as suggested by Pallant (2010).

Checking for Equality of Covariance Matrices (Box's M test)

Table 5 shows the result of the Box's M test that checks the assumption of homogeneity of covariance across groups. From the result, sig. value of .111 is larger than .001; hence the assumption of homogeneity of variance-covariance matrices is not violated.

Table 5: Box's Test of equality of Covariance Matrices.

Box's M	44.509
F	1.324
df1	30
df2	13843.338
Sig.	.111

Checking for Equality of Error Variances (Lavene's Test)

Table 6 presents the result of the Lavene's test that checks the assumption of homogeneity of variance across groups. The results show that all the sig. value (i.e., .913, .197, .744, .876, and .652) are greater than .001; hence the assumption of homogeneity of variance is not violated.

Table 6: Lavene's Test.

	F	df1	df2	***Sig.***
Perception on the scenario (extent) of corruption in Malaysia	.091	2	68	***.913***
Vulnerable areas for corruption in the construction project development	1.664	2	68	***.197***
Reasons for corruption (sources)	.298	2	68	***.744***
Effects of corruption	.132	2	68	***.876***
Anti-corruption strategies	.431	2	68	***.652***

Mutivariate Test

Table 7 shows the multivariate test of significance that will indicate whether there are statistically significant differences among respondents' groups on a linear combination of the dependent variables. Based on the result, the sig. value for Wilk's Lambda of .041 is smaller than .05 which indicates that there is a statistically significant difference between the respondents in terms of the items of corruption.

Table 7: Multivariate Tests[a].

Effect		**Value**	**F**	**Hypothesis df**	**Error df**	**Sig.**	**Partial Eta Squared**
Intercept	Pillai's Trace	.987	979.338[b]	5.000	64.000	.000	.987
	Wilks' Lambda	.013	979.338[b]	5.000	64.000	.000	.987
	Hotelling's Trace	76.511	979.338[b]	5.000	64.000	.000	.987
	Roy's Largest Root	76.511	979.338[b]	5.000	64.000	.000	.987
Organisations	Pillai's Trace	.259	1.934	10.000	130.000	.046	.130
	Wilks' Lambda	***.750***	***1.980[b]***	***10.000***	***128.000***	***.041***	***.134***
	Hotelling's Trace	.321	2.024	10.000	126.000	.036	.138
	Roy's Largest Root	.278	3.615[c]	5.000	65.000	.006	.218

a. Design: Intercept + Organisations
b. Exact statistic
c. The statistic is an upper bound on F that yields a lower bound on the significance level.

Whereby Table 8 shows the results for Tests of Between-Subject Effects. Due to the significant result, a follow up test was conducted to explain the group differences. Since at this point a number of separate analyses were being looked into, Pallant (2010) suggested to set a higher alpha level to reduce the chance of the Type 1 error. This was done by applying the Bonferroni adjustment through dividing the original alpha level (i.e., .05) by the number of analyses intended (i.e., 5). Hence, for this research the new alpha was changed to .01 and the result would be considered significant only if the probability value (Sig.) was less than .01. Based on the result, the only significant difference between the three groups of respondents (i.e., Government agencies, contractors, and consultants) was on the vulnerable areas of corruption in the construction project development. The importance of the impact of different respondents from different organisations on vulnerable areas of corruption can be evaluated using the effect size statistic utilising the value of Partial *eta* squared. The value in this case is .196 which according to Cohen (1988) in Pallant (2010) is considered a large effect. This represents about 19.6 percent of the variance in vulnerable areas of corruption explained by the three groups of respondents.

Table 8: Tests of Between-Subjects Effects.

Source	**Dependent Variable**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	***Partial Eta Squared***
Organisations	Extent (Culture)	1037.157	2	518.578	3.914	.025	.103
	Areas	***656.478***	***2***	***328.239***	***8.269***	***.001***	***.196***
	Source: Technical	777.294	2	388.647	1.714	.188	.048
	Effects	30.561	2	15.281	.105	.901	.003
	Strategies	376.728	2	188.364	1.174	.315	.033

Table 9 shows the estimated marginal means in order to know the difference of mean scores between the groups. For vulnerable areas of corruption, the mean score for contractors is 25.080, government agencies is 19.640, and consultants is 26.762.

Table 9: Estimated Marginal Means.

Organisations

Dependent Variable	**Organisations**	**Mean**	**Std. Error**	**95% Confidence Interval**	
				Lower Bound	**Upper Bound**
Extent (Culture)	Contractors	44.320	2.302	39.726	48.914
	Government agencies	35.600	2.302	31.006	40.194

	Consultants	42.381	2.512	37.368	47.393
Areas	Contractors	*25.080*	1.260	22.565	27.595
	Government agencies	***19.640***	***1.260***	***17.125***	***22.155***
	Consultants	*26.762*	1.375	24.018	29.505
Source: Technical	Contractors	84.480	3.012	78.470	90.490
	Government agencies	76.920	3.012	70.910	82.930
	Consultants	82.762	3.286	76.204	89.320
Effects	Contractors	64.320	2.417	59.496	69.144
	Government agencies	65.800	2.417	60.976	70.624
	Consultants	65.524	2.638	60.261	70.787
Strategies	Contractors	79.200	2.533	74.145	84.255
	Government agencies	73.720	2.533	68.665	78.775
	Consultants	76.762	2.764	71.246	82.278

With that, Government agencies were found to have different perception on the vulnerable areas of corruption compared to contractors and consultants while the mean score for contractors and consultant are almost similar (less than 1 scale point). This shows that contractors and consultants might have the same perception on the vulnerable areas for corruption but different when compared with the Government agencies.

DISCUSSION OF FINDINGS

A multivariate analysis of variance was conducted to assess if there were differences of opinions between the three respondents (i.e., Government agencies, contractors, and consultants) on the item of corruption including vulnerable areas of opportunities for corruption, sources of corruption in terms of technical, effects of corruption, extent of corruption, and anti-corruption strategies available. The assumptions of independence of observations and homogeneity of variance-covariance were checked and met. Mahalanobis distance were checked for multivariate normality with no serious violation noted. A statistically significance difference was found, Wilk's Λ=.750, $F(10,128)=1.98$. $p=.041$, multivariate $\eta2= .13$. When the result for dependent variables were considered separately, using a Bonferroni adjusted alpha level of .01, the difference in opinion between the respondents (i.e., Government agencies, contractors, and consultants) existed in the vulnerable areas for corruption in the construction project development with $F(2,68)=8.269$, $p=.001$.

However, the remaining four issues (i.e., sources of corruption, effects of corruption, extent of corruption, and anti-corruption strategies) are similar in opinion between the three groups of respondents. This implies that the result did not support the hypothesis of 'there is no significant difference between the three groups of respondents (i.e., Government agencies, contractors, and consultants) in perception of the issues of corruption'. Hence, it could be deduced that H01 cannot be accepted.

The reason for this predicament may be due to the involvement of the different stakeholders in the different phases across the construction project development that leads to the difference in perception on which phase creates more opportunities for corruption. Adding to that, the result revealed that Government agencies were found to have different perceptions on the vulnerable areas of corruption compared to contractors and consultants. The probable reason for this predicament is that government tend to hide information on corruption (Olken, 2009) suggesting that the definition of corruption on the abuse of powers by public officials for private gain is true. Besides, this result inclines to support various reports on public officials or civil servants that is condemned as a notably corrupt sector (TI's GCB).

CONCLUSION

In summary, it is noteworthy that there is a difference in perception between the government agencies, the contractors, and consultants in terms of areas vulnerable for corruption. This may be due to the involvement of different stakeholders in the different phases across the construction project development. Besides, the opportunities of corruption within the various phases may be the result of a difference in scope of work and authorities by the various stakeholders. Therefore, it is inevitable to consider the differences in order to develop significant anti-corruption strategies.

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GEOSPATIAL ANALYSIS OF SUSTAINABLE LIVING RESIDENTIAL SITE SUITABILITY USING ANALYTICAL HIERARCHY PROCESS

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Abstract

The demand for sustainable housing is rising because of the rapid increase in Malaysia's population. Housing areas with sufficient amenities, services, and accessibility contribute to people's having a higher quality of life since those amenities might satisfy their desire for a particular location. This study intends to identify significant parameters, weightage, and sustainable residential areas based on selected parameters. The Analytical Hierarchy Process (AHP) and the Geographical Information System (GIS) platform were used to assess the appropriate parameters and locations with adequate facility supply. To determine the suitability of residential areas in Ipoh, Perak, the weighted overlay approach was performed using the computed value and scale of the parameters. A site suitability map is created using three separate levels with low, medium, and high suitability areas. The most important parameters were found to be health and social care, while industrial areas, social amenities, and recreational places were found to be less important. With this outcome, purchasers could discover the most important regions that fulfil their demands by making the decision to invest in the right residential property.

Keywords*:* Geospatial Analysis, Residential Site Suitability, AHP

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INTRODUCTION

The United Nations Sustainable Development Goals (SDGs) 11 defines sustainable residential as a high-quality housing development (cities and communities) with better dependability and impacts on nature and the environment (Chen, 2014). Sustainability provides a variety of approaches for balancing human needs and the protection of the environment to preserve future generations' rights and requirements for sustainable development (Mohamadzadeh et al., 2020). To ensure sustainable living and create safe cities, social and physical infrastructure, including accessibility, sewer efficiency, and green public areas potentially affect people's abilities and should be seriously considered in residential planning regulations (Abrabba et al., 2022). However, the process requires balancing among several criteria; thus, the analytical hierarchy process (AHP) with the GIS platform, a multi-criteria decision analysis (MCDA) technique is widely used to generate coefficients that provide the basis for real building valuation (Bunyan Unel & Yalpir, 2019). The AHP utilizes pairwise comparisons by analysing the opinions of experts about all the criteria that may affect the property's value. The outcome of the pairwise comparison is the weight assigned to each variable for the determination of the property's true value.

The hedonic pricing model and ordinary least squares (OLS) are also additional approaches to assist with better decision-making about house pricing (Aladwan & Ahamad, 2019; Maryam et al., 2022). To build a sustainable residential area, it is always essential to identify the adequacy of the parameters to be considered in the AHP process (Masri et al., 2016). This study will assist homebuyers in selecting residential real estate investments that fulfil their demands and everyday activities. Moreover, it is expected that the outcome of the research will provide information for urban planners and developers in deciding profitable locations for property development.

LITERATURE REVIEW

A sustainable community is described as a neighbourhood with satisfactory living conditions and sustainable housing indicators for a high-quality life (Qusen Zumaya & Baqir Motlak, 2021). Every sustainable community would provide social amenities, infrastructure, safety, and privacy to enhance the residents' quality of life that meet their needs and demands. The selection of location is vital to sustainable residential housing development because it affects human development and livability (Murseli & Isufi, 2014) since the location influences the sustainability of the residential and market price, social amenities, accessibility, and available services require more attention (Ahmad & Matori, 2016; Masri et al., 2016). The parameters of the built environment, specifically for the dwelling area, such as services offered, commercial areas, accessibility, and other amenities, have to be balanced in relation to the walking distance and travel durations from one location to another during the decision-making process (Chen, 2014; van Maarseveen et al., 2018). These are also inclusive of other amenities like retail centres, schools, green spaces, industrial facilities, and the recreational area that prospective users and investors desired (Aburas et al., 2017).

Because of the complexity and intricacies of the interdependency and interrelationship of these requirements, multi-criteria decision analysis (MCDA) is a suitable tool for property assessment. First, a site suitability study is required to provide benchmarks for planning and property evaluation (Ilayaraja et al., 2016). A number of studies have integrated MCDA and GIS to speed up the process of selecting suitable locations (Chen, 2014; Malczewski, 2006; Mokhtar et al., 2020) and as a basis to evaluate the value of the real estate (Bunyan Unel & Yalpir, 2019). In this respect, the process combines geographical data (GIS) and the value of judgments (factor weights) to aid decision-making (Malczewski, 2006; Mokhtar et al., 2020; Nur Ezra et al., 2018).

RESEARCH METHODOLOGY

The study area selected for this study is Ipoh, Perak, Malaysia. The location is selected because it is the third largest state in Malaysia which comprises both urban and suburban areas and has experienced rapid development in recent decades (Khahro et al., 2014). Figure 1 shows the detailed research methodology. The parameters used in this work were obtained from the study of Mokhtar et al. (2020) with the addition of two (2) new parameters, social amenities, and recreational areas, to test whether the parameters influence the result in comparison to the work of Yenisetty and Bahadure (2020). A good quality social amenity is known to create a good community and a recreational area with the presence of green space is positively correlated with the neighbourhood's air quality (van Maarseveen et al., 2018). The selection of the parameters is based on the availability of the parameters in the study area (Table 1).

Table 6: List of parameters used in Three (3) Different Studies

Authors & Year	Parameters
Mokhtar et al. (2020)	Health & Social Care, Available Service, School, Public Defense, Accessibility, Government Building, Place of Interest, Housing Area, Commercial Area, Industrial Area
Ahmad & Matori (2016)	Recreational area
Yenisetty & Bahadure (2020)	Social Amenities

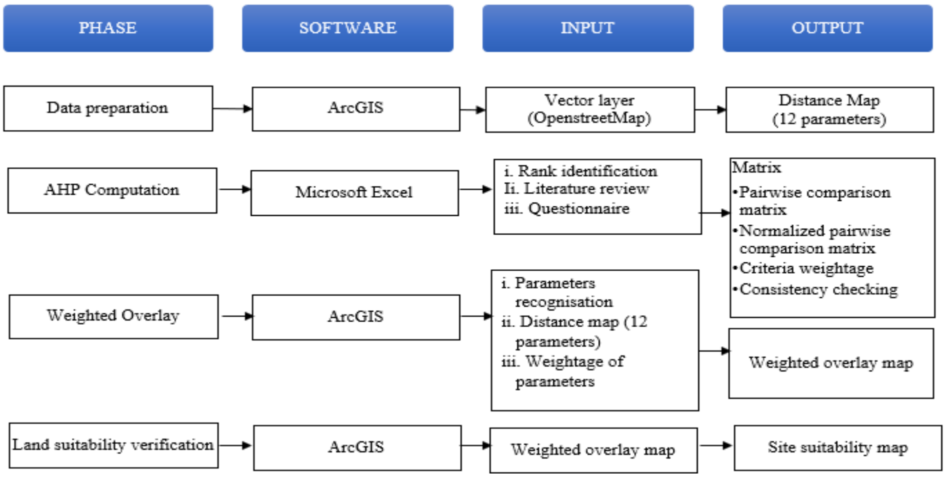

Figure 7: Overall Methodology

Data Used and Preparation

From OpenStreetMap (openstreetmap.org), the spatial dataset including accessibility features and other parameters used in the study was downloaded. OpenStreetMap is a platform for acquiring free vector data, which can be downloaded in OSM format for further processing in a GIS environment. The data obtained were converted into geodatabase files in ArcGIS 10.4. This study involves the classification of 12 variables (Table 2) projected to the Kertau RSO projection.

Table 2: Layer Classification of Twelve (12) Parameters.

Parameters/Ranking	**1**	**2**	**3**
	Distance Classification (m)		
Distance to Health and Social Care	0 – 2478	2478 – 4924	4924 – 9446
Distance to Available Service	0 – 1856	1856 – 3902	3902 – 7607
Distance to School	0 – 1793	1793 – 3958	3958 – 7643
Distance to Public Defense	0 – 2865	2865 – 5297	5297 – 9395
Distance to Accessibility	0 – 2747	2747 – 5021	5021 – 8956
Distance to Government Building	0 – 1867	1867 – 3767	3767 – 6938
Distance to Place of Interest	0 – 1217	1217 – 2493	2493 – 5350
Distance to Housing Area	0 – 134	134 – 385	385 - 1193
Distance to Commercial Area	0 – 650	650 – 1521	1521 - 3259
Distance to Industrial Area	3294 - 6698	1768 – 3294	0 – 1768
Distance to Social Amenities	0 – 1302	1302 – 2666	2666 - 5354
Distance to Recreational Area	0 – 1221	1221 – 2382	2382 - 5106

The Euclidean Distance Tool in the ArcGIS spatial analyst is used to determine the distance to a location of the sample data since it is an effective method for evaluating environmental exposure distance (Aburas et al., 2017). It is utilised to extract the distance class for each parameter in this study. It computed the distance between the feature or point's centre and the centres of the surrounding cells. The range of distance classification layer represents the indices to the amenities that were produced by natural breaks classification (Aburas et al., 2017) and have been reclassified into three new classes consisting of low suitability (3), medium suitability (2), and high suitability (1) (Kamalov, 2020), resulting in a raster remap. If the distance to the point or feature is less, the scale indicating the level of difficulty to reach the facilities will also be reduced. The 12 data layers and their categorization are presented in Table 2.

AHP and GIS based for Site Suitability Analysis and Mapping

Using the AHP, the pairwise comparison was conducted which provided the weighting values that reflect the significance of each parameter (Malczewski, 2006). The scale was set from one (1), which indicates equal value, to nine (9), which represents the most significant aspect (Santosh et al., 2018). The upper diagonal of the pairwise comparison matrices was allocated a numeric rank, whereas the bottom diagonal was awarded a reciprocal value. Each variable's criterion weight was computed by dividing the value assigned in the matrices by the total value of the variables. Based on the normalised pairwise comparison matrices, the weighted sum value matrix was produced by multiplying the matrix value by the obtained criteria weight. The value of the weighted sum was divided according to the variable weighted values. The final output is utilised to estimate the consistency ratio (CR) which indicates whether consistent judgements are made between the parameters. When the CR number surpasses 0.1, it indicates that the judgement is unacceptable and has to be repeated (Bunyan Unel & Yalpir, 2019) but when the CR value is less than 0.1, the AHP process is acceptable. The ratio of the weighted sum value, the highest eigenvalue (λ_max) of the matrix, the consistency index (CI), and lastly the consistency ratio (CR) are essential judgements for the computation (Bozdağ et al., 2016). The consistency ratio (CR) is determined based on the random index (RI) value (Malczewski, 2006).

Once the result of the AHP process is satisfactory, the site suitability mapping is performed using the overlay method in ArcGIS using the reclassified layers and the AHP-calculated weights. The weighted overlay integrates raster data and weights and converts them into a raster map that depicts specific land suitability classes (low, medium, and high suitability) based on the relationship between the parameters (Roslee et al., 2017). Finally, the suitability map was exported and generated into a Google Earth image for validation.

RESULT AND DISCUSSION

According to Aburas et al. (2017), CR > 0.10 indicates inconsistent judgements, whilst CR < 0.10 indicates an acceptable ratio value for the judgement. The weights of the 10 and 12 parameter categories are shown in Table 3. The CI, RI, and CR values demonstrate significantly superior outcomes than Ilayaraja et al. (2016) which is 0.15. To maintain the uniformity of every parameter, the AHP ranking of certain parameters was revised. Table 4 shows the greatest eigenvalue (13.741) which resulted in the calculated CI and CR values being 0.16 and 0.10, respectively, showing that the evaluation had near-inconsistent judgements but was still rated as acceptable. Weighted overlay analysis was used to generate a map of residential land suitability (Figure 2), which reveals that the city's centre is the most attractive location for homebuyers because it encompasses all twelve (12) parameters. It is due to providing convenient access to a wide variety of services and facilities that residents need and use on a regular basis. Most of the conveniences are concentrated in the central business district (CBD) (Figure 2). The central part of the map is more suitable than the outlying areas because it is closer to the central business district (CBD), which is where the mapped region is located.

Table 3: The computed value of weightage, CI, RI, and CR of previous work.

SET	Parameters	CW	CI	RI	CR
1 (Mokhtar et al., 2020)	Health and Social Care	0.30	0.23	1.49	0.15
	Available Service	0.22			
	School	0.13			
	Public Defense	0.10			
	Accessibility	0.08			
	Government Building	0.04			
	Place of Interest	0.04			
	Housing Area	0.04			
	Commercial Area	0.03			
	Industrial Area	0.02			
2 (Revised Weightage and Parameters)	Health and Social Care	0.28	0.16	1.54	0.10
	Available Service	0.21			
	School	0.13			
	Public Defense	0.10			
	Accessibility	0.09			
	Government Building	0.04			
	Place of Interest	0.04			
	Housing Area	0.04			
	Commercial Area	0.03			
	Industrial Area	0.02			
	Social Amenities	0.02			
	Recreational Area	0.02			

Table 5 shows a list of available parameters at the chosen location for each suitability level of a sustainable residential living area. The residential area was identified as the selected area, which was mapped using the Google Earth platform (Figure 3). In Ipoh, Perak, most of the residential areas are found in the high- and medium-suitability regions, which are filled with amenities and accessibility. Most amenities were concentrated in the CBD region, which indicated that it offered more sustainable living than neighbourhoods away from the CBD. In areas with scarce facilities, such as Bandar Lahat Baru (Figure 2), there are fewer amenities and unfavourable parameters, such as an industrial area that is regarded as a dangerous facility. A study by van Maarseveen et al. (2018) found that potential purchasers' willingness to purchase a residential property was influenced by the distance between housing and the industrial sector. Due to its ability to shorten travel times, people prefer to invest in residential real estate that meets the most sustainable residential criteria.

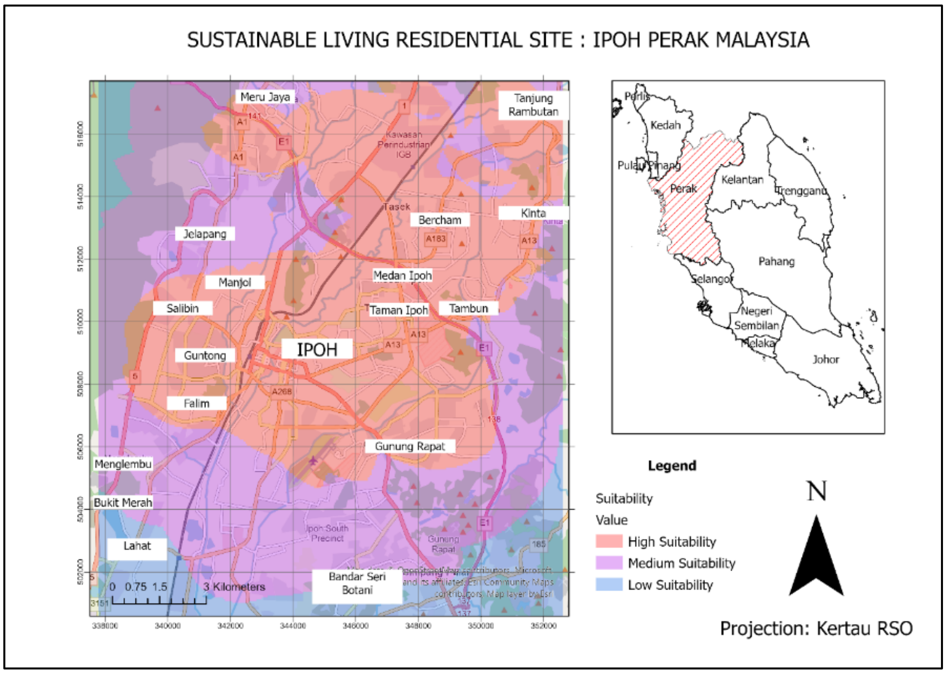

Figure 2: Suitability Residential Living Area Map

Table 4: The consistency ratio of twelve (12) parameters.

Parameters		**(A)**	**(B)**	**(C)**	**(D)**	**(E)**	**(F)**	**(G)**	**(H)**	**(I)**	**(J)**	**(K)**	**(L)**	**Weighted Sum Value**	**Criteria Weight**	**Ratio**
Health and Social care	**(A)**	0.28	0.41	0.50	0.49	0.52	0.31	0.30	0.33	0.28	0.20	0.14	0.17	3.93	0.28	14.282
Available Service	**(B)**	0.14	0.21	0.25	0.39	0.43	0.26	0.26	0.29	0.25	0.17	0.14	0.17	2.98	0.21	14.481
School	**(C)**	0.07	0.10	0.13	0.20	0.34	0.22	0.23	0.11	0.13	0.15	0.13	0.06	1.85	0.13	14.739
Public Defense	**(D)**	0.06	0.05	0.06	0.10	0.17	0.18	0.19	0.11	0.16	0.12	0.10	0.11	1.40	0.10	14.236
Accessibility	**(E)**	0.05	0.04	0.03	0.05	0.09	0.09	0.15	0.18	0.25	0.10	0.10	0.09	1.22	0.09	14.135
Government Building	**(F)**	0.04	0.03	0.03	0.02	0.04	0.04	0.08	0.07	0.06	0.07	0.05	0.06	0.60	0.04	13.667
Place of Interest	**(G)**	0.04	0.03	0.02	0.02	0.02	0.02	0.04	0.07	0.09	0.10	0.03	0.04	0.52	0.04	13.860
Housing Area	**(H)**	0.03	0.03	0.04	0.03	0.02	0.02	0.02	0.04	0.06	0.12	0.05	0.04	0.50	0.04	13.554
Commercial Area	**(I)**	0.03	0.03	0.03	0.02	0.01	0.02	0.01	0.02	0.03	0.15	0.03	0.04	0.42	0.03	13.394
Industrial Area	**(J)**	0.05	0.05	0.04	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.03	0.04	0.31	0.02	12.252
Social Amenities	**(K)**	0.03	0.02	0.02	0.02	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.02	0.21	0.02	13.032
Recreational	**(L)**	0.03	0.02	0.04	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.24	0.02	13.265

Table 5: Availability Facilities at the Selected Location with Different Levels of Sustainability Residential Area

Level Suitability	Location	Parameters Available
High	Falim	Health & Social Care, Public Defence, School, Place of Interest, Commercial Area, Social Amenities, Government Building, Industrial Area, Available Service, Housing Area, Recreational Area, Accessibility
Medium	Taman Taufik	Commercial Area, School, Industrial Area, Accessibility, Social Amenities, Available Service, Recreational Area, Housing Area
Low	Bandar Lahat Baru	Industrial Area, Commercial Area, Housing Area, Accessibility

CONCLUSION

The purpose of the study was to determine the suitability of residential property sites in Ipoh and to produce the site suitability map. The distance from each relevant metric was analysed and categorised into high (1), medium (2), and low (3) suitability. The inconsistency in the previous study which employed 10 parameters has been verified. Even though the value was nearly discordant with the evaluations, the CR value of 0.10 indicates that the parameter evaluations were acceptable and reliable. Most of the residential areas in Ipoh, Perak are detected within high and medium suitability zones, compared to the low suitability area, which occurs mostly in the less developed area with population and limited infrastructure. The result also revealed that the most significant parameters are health and social care while industrial areas, social facilities, and recreational places have little significance. It can be inferred that since most of the parameters are not available at remote locations far away from the central business district, they are found unsuitable for a sustainable residential neighbourhood. The addition of two other factors affects the area occupied by the various classes compared to the previous study (Ahmad & Matori, 2016).

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IMPROVEMENTS OF THE COMMUNICATION BETWEEN CONSULTANTS AND CONTRACTORS DURING THE CONSTRUCTION PHASE IN MALAYSIA

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Abstract

Effective communication is becoming increasingly important in project construction because of the growing demands of the projects. Fundamental to the successful delivery of projects in the construction industry is high-quality communications. The objectives of this paper were to investigate communication methods commonly used in construction projects, to identify factors contributing to communication breakdown, and to suggest actions to minimise communication breakdown during the construction phase between consultants and contractors. Through a comprehensive literature review the communication channels, modes and mediums were recognised. The contributing factors were categorised into project characteristics, personal attitude, communication method, communication management, communication barrier and external aspect. While, the actions to minimise communication breakdown were extracted from previous studies and classified into communication development, communication management and communication method. A quantitative method (questionnaire survey) with a close-ended questionnaire with experienced industry practitioners from a large population of 135 respondents comprising consultants, contractors and developers was used for the data collection. It produced results that generalise, compare and summarise all collected data. The study identified personal attitude as the highest contributor to communication breakdown and communication management was the most effective element to minimise the communication breakdown. It would take a combined effort on the part of all construction parties from consultants, contractors and subcontractors to the project owner to minimise communication breakdown. The findings might help to achieve project success through the improvement of communication between consultants and contractors during the construction phase.

Keyword: Communication breakdown, contributing factors, project success, construction, contractor and sub contractor.

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INTRODUCTION

Communication is seen as an important component in the project management process. The set of standard terminology and guidelines created by the Project Management Institute (PMI) for project management is known as the project management knowledge area. The standard is evolving and periodically updated in its Project Management Body of Knowledge (PMBoK). There were ten areas of project management knowledge, which coincide within the project management process group. One of the knowledge areas was communications management.

Despite the emphasis on the importance of communication in project management, the problem in the construction industry often referred to as communication problems. The communication problem was increasingly recognised as a serious and concern issue to the construction players. Olanrewaju et al. (2017) stated in their study that the construction sector in Malaysia was experiencing high cases of delays, cost and time overruns, poor quality, health and safety issues, pollution and sustainability issues as a result of ineffective communication practices. Olanrewaju et al. (2017) and Soetanto et al. (2015) claimed that poor communication was the root of poor performance in the design and construction of the Malaysian construction sector. Yap et al. (2018) added that the issue of lack of communication among the contracting parties had plagued the construction industry particularly concerning delay management and cost control, and constitute the major factors of time-cost overruns in Malaysia. Communication processes were an essential element in delivering information flow forwards, sideways, backward within an organisation to another organisation (Ahmad Pozin et al., 2018). As reported by (Ahmad Pozin et al., 2018), in recent years, effective communication was becoming increasingly important in project construction because of the growing demands of the projects, along with the heavy amounts of technical work and the complexity of the supply chain process. Alzeraa et al. (2018) mentioned that project success might be significantly influenced by project communications, besides human elements and interpersonal relations. While, a study made by Lee et al. (2018) reported that when a question about the main driver for delivering a successful construction project was asked to project managers through a survey, communication was the most common answer received. Without doubt, Esther Paik et al. (2017) and Tran et al. (2017) stated that communication was among the factor which was vital for project success. Reza Hosseini et al. (2017) highlights that the fundamental to the successful delivery of projects in the construction industry was high-quality communications. Therefore, construction project success relies much on the communication aspect. However, the problem that frequently occur in construction projects was ineffective communication (Djajalaksana et al., 2017; Ejohwomu et al., 2017; Gamil and Abdul Rahman, 2020; Nursin et al.,2018; Yap and Skitmore, 2018), lack of communication (Butt et al., 2016; Olanrewaju et al., 2017; Pozin et al., 2016), lack of effective communication (Alves and Shah, 2018) poor management of communication (Gamil et al., 2020), poor communication (Soetanto et al., 2015; Tafazzoli et al., 2017), bad communication (Oladokun et al., 2018) and improper communication (Gamil et al., 2020).

According to Badi et al. (2017), construction projects require multidisciplinary communication and collaboration as it was related to excessive complexity and involve massive amounts of building data. Data obtained from previous studies show that several types, networks, mediums, ways and channels available to be used by construction players to transmit communication within themselves. However, much uncertainty still exists about the appropriate and preferred method of communication to connect consultants and contractors effectively and efficiently, during the construction phase. Recent researches mostly explore the use of WhatsApp (Ahmad Pozin et al., 2018), virtual design and construction (Hassan et al., 2018), cloud computing (Mohd Fateh et al., 2016; Othman et al., 2018) and virtual environment (Pozin et al., 2017), as communication applications among the construction players to investigate on its effectiveness in improving communication.

This study, however, will not approach in detail Information and Communication Technology (ICT). Instead, it focussed to suggest the other sides of best practices for corrective action to achieve the most effective and efficient communication into the minimisation of communication breakdown. Regarding these matters, the sources and causes of communication breakdown shall be identified to find the ways to minimise communication problems from occurring in construction projects henceforth improve communication between contracting parties to the construction industry.

LITERATURE REVIEW

Communication in Construction Industry

Taleb et al. (2017) and Alqaisi, (2018) explain that communication was the lifeblood of any system of every human interaction. Studies also stated that, without communication, knowledge exchange would never occur (Ahmad Pozin & Mohd Nawi, 2018) and no meaningful or coherent activity can take place (Alqaisi, 2018). The communication environment of the project teams or members mainly involves various players from the developers, landowners, consultants, local authorities, service providers, relevant government departments, contractors, subcontractors, suppliers and manufacturers. Therefore, as mentioned by Alzeraa et al. (2018), communication takes place not only between individuals who were involved in a construction project but it was involving many organisations. Therefore, communication indeed was very significant to the construction industry. The main functions of communication, as informed by Kwofie et al. (2017) includes controlling, to give motivation, showing emotional expression and information transmission. Communication as introduced by the Project Management Institute (PMI) is the movement of information from one point in an organisation to another. In projects, this must happen well between the construction players. Communication in construction project teams, as presented by Reza Hosseini et al. (2017), requires an element of persuasion and conviction where sender of information should become able to convince the receiver about some aspect of design and engineering calculations. Other than that, Tran et al. (2017) declared that communication in construction management was a means of interacting with personnel involved in a project. Communication was a very important factor in the construction field and this was confirmed through interviews conducted by Oladokun and Alshaikh (2018), and supported by Olanrewaju et al (2017) in their study. The study said that at every stage of the construction lifecycle, information needs to be stored, retrieved, and communicated. In the meantime, C. Wu et al. (2017) raised the importance of communication due to its centralised nature whereby each construction project team had different responsibilities and different times to join the project. As for the matter, C. Wu et al. (2017) saw construction projects were typically characterised by high uncertainty, complexity and inter-organisational task interdependence, which makes communication even more important.

The Construction Phase

A 'construction project' was clarified by Badi and Diamantidou (2017) as a network of organisations bounded by flows of information exchange and communicational networks of relationships. Process of a construction project basically was divided into three main phases which were pre-construction, during construction and post-construction. As per traditional construction procurement, construction parties involved during the pre-construction phase were only consultants. Meanwhile, for phase during construction and post-construction, the project teams consist of both consultants and contractor who were taking responsibility of the construction project within a certain period of time, dependant on the respective condition of a contract. Meanwhile, the post-construction phase commences when the project was handed over to the client. Prior to the engagement of both consultants and contractors. The client may or may not stipulate on the communication medium to be practised along the contract period. Stage of during construction usually is addressed by most studies as the project implementation phase. G. Wu et al. (2017) stated that project teams were involved in resource exchange and information communication during project implementation. The study adds at the particular stage of construction work, a situation of the construction project team, both internal and external, was complex. Construction phase involving activities of implementation and management of work on-site based on the approval obtained from respective authorities in the pre-construction phase.

Methods and Modes of Communication

Djajalaksana et al. (2017) explicated that those methods of communication fall under the vital element of project management. The communication methods were commonly applied in the construction industry, worldwide. This paper was focusing on the communication methods practised by consultants and contractors during the construction phase, excluding the computer software such as Building Information Modelling (BIM) of Information and Communication Technology (ICT) which were explored by most of the previous studies. Literatures stated that the main types of communication were verbal, non-verbal, written and visual. Al-Mayahi et al. (2018) settled those modes of the communication process include the appropriate selection of communication medium which varies depending on the type and phase of the project. The communication medium could be in the form of softcopy or hardcopy which dependant on the types of communication used to deliver the messages. Lee et al. (2018) marked off on the use of visual communication as a better mode of communication to be practised in the construction industry. The argument was visual communication was useful for better understanding of information in the construction project and used to aid effective communication between project participants.

Contribution Factors to Communication Breakdown

Collins English Dictionary marks out communication breakdown as a lack of communication or a failure to exchange information and Fitri Othman et al. (2017) described communication breakdown as a breakup of information flow and failure of coordination process in project management. Ineffective communication amongst construction project stakeholders, as identified by Ejohwomu et al. (2017) through empirical evidence, exists as a significant factor accountable for the poor performance of construction projects. A study by Djajalaksana et al. (2017) also raised the recurring issue of ineffective communication which had been published as a top reason causal to failure of a construction project, though the importance of communication had been made known. Apart from ineffective communication, another communication issue as recorded by Wen Lim et al. (2018) was decreasing willingness to communicate. The study elaborates that project teams were refusing to share their information without interpersonal trust. Hassan et al. (2018) emphasised that the construction industry was highly fragmented and multidisciplinary whereby the client's stress their expectation and requirement to be fulfilled. Therefore, effective communication among disciplines was crucial for a construction project to be successfully executed, as the fragmented nature of the industry would bring difficulties to all professions involved to meet the client's expectations.

Minimisation of Communication Breakdown

From the findings of the literature review, the impact of communication breakdown resulted in a negative impact rather than a positive impact. Communication breakdown affects the overall performance of the construction project as well as construction players who were appointed to carry out the work, within the stipulated time, cost, quality, safety and health. There upon, the right practice of effective and efficient communication was needed to minimise the issue of communication breakdown from affecting the construction projects and resulting in loss to the client. Oladokun et al. (2018) perceived improving communication as an essential solution to the communication breakdown. While empirical evidence through the study by Ejohwomu et al. (2017) showed the importance of skills in improving the effectiveness of communication.

The construction phase required many considerations to be taken into account like who needs information, authorised people to access information, the time they would be calling for information, where and in what format to store the information, and how to retrieve them, as introduced by Taleb et al. (2017). First and foremost, Taleb et al. (2017) suggested critical skills on a clear understanding of how communication takes place and how to apply it effectively and efficiently, should be acquired to minimise communication breakdown. Later on, Djajalaksana et al. (2017) revealed the chain of communication needs to be passed on from the designer either the architect and engineers to the one who actually 'builds' the design, which was the contractor. All those parties shall be involved in the coordination and sequence of the work, throughout the construction period. Other than that, Kwofie et al. (2017) underlined that influencing and achieving effective communication require construction players to absorb the knowledge and understand the nature and features of construction project typologies as well as its intrinsic communication ineffectiveness from its unique attributes. The effectiveness of communication during the construction phase initially contributed by the preparation made during the pre-construction stage. Project initiation by the client itself must be comprehensively done to help smooth communication and interaction during the construction phase. A study by Kwofie et al. (2017) testimonies that construction players who communicate by acclimatising to the project's characteristics and the project's context were more likely to be successful and promote team effectiveness.

RESEARCH METHODOLOGY

The data collection of this study involved the collection of both secondary data which was the literature review and primary data through a questionnaire survey.

A further step was processing data analysis to the content and descriptive analysis upon gathering all the data collected. The questionnaire survey was selected to collect quantitative data in a regular course to obtain compatible and orderly data. It was used to keep the facts of the respondents in the demographic background as well as occupational information of the respondents before further deep into the respondent's common practice and experiences. Through the small scale of a pilot test, several questions in the preliminary questionnaire set had been eliminated, revised and reworded for a better understanding of the prospective respondents. The pilot test helped to collect reliable feedback, validate the content of the instrument, determine the effectiveness of the survey design, check the people understanding together with the ability to answer the questionnaire. All feedbacks were incorporated into the final set of the questionnaire before distributing the questionnaire. The questionnaire was developed to cover all the data related to the research objectives. The survey questionnaire which consisted of a series of questions was divided into four sections including demographic background and organisation information of the respondents:

- **Section A:** pursued the interest and desire of respondents in their cooperation to influence the attitude of the respondents to be part of the questionnaire. Subsequent sections represent each research objective in the sequence of the study. Each of the sections was subdivided and arranged into several related categories of 3 to a maximum of 6 categories.
- **Section B:** intended to reflect consultants' and contractors' attitudes and routine in using various modes and mediums of communication to transmit their messages to each other.
- **Section C**: determined to establish a level of agreement among the consultants and contractors based on the list of factors that contribute to communication breakdown.
- **Section D**: The last section of the questionnaire contemplated ranking the level of effectiveness for each initiative to minimise communication breakdown retrieved from previous studies.

For Section A, the selection of answers was varying. There were questions where only one answer was allowable and some questions open for multiple picks. However, for Section B to Section D, 5-point of three different Likert scales were incorporated to suit the research questions and at the same time, enable responses to be given on a continuum. The questionnaire was composed of straightforward questions through the use of simple and specific English language.

The respondents of the study were consultants and contractors related to the construction industry who involved in during the construction phase and dealing with either consultant and / or contractors. The contractors include main contractors and nominated contractors with Grade 7 (G7) qualification certified by the Construction Industry Development Board (CIDB). Primary data of the study were collected from samples with various ranges of age, profession and year of experience in the construction industry. Eligibility criteria required individuals to have graduated with at least a Diploma, not less than 21 years old and have working experience. The estimated population parameter of consultants who have registered with respective professional bodies and Grade 7 contractors who have registered with the Construction Industry Development Board (CIDB), within Malaysia was not more than thirty thousand (30,000). Therefore, stratified sampling was used. The respondents were divided into two groups, contractor and consultant. Both groups will represent the population of the study. From the formula by Krejcie et al. (1970), for a thirty thousand (30,000) population, the sample size is 379 respondents.

The questionnaire was documented in two versions which were Google form and the paper-pencil version. The confidentiality of quantitative respondents was maintained for the study. The invitations were made by sharing the link of the web survey of Google form with a short introduction to several contacts through social media of WhatsApp application and electronic mail. Due to some requests from the prospective respondent and to easily approach prospective respondent, the questionnaire also had been distributed in a hardcopy of the paper-pencil questionnaire. The data collection began upon completion of a pilot test by inviting prospective respondents to participate in the questionnaires over many possible ways to achieve the sample size of respondents as established by Krejcie et al. (1970). At the end of the data collection, the study managed to collect 135 out of 386 number of questionnaires distributed. It translates to thirty-five (35%) of the response rate. The rate was acceptable for a self-administrated survey (Mohd Fateh et al., 2019).

The questionnaire survey was analysed on the frequency, percentage, mean and ranking to the spread of scores and general tendencies in the data. Mean then was produced to spot the ranking amongst variables of the same category and also ranking amongst categories of variables for Section B to D. The summary of the statistics was tabulated and graphed for better understanding and a clearer picture of the analysis. The paper-pencil based questionnaires were documented into the Google form format and export to Microsoft Excel. All the collected data of the quantitative method then were imported from Microsoft Excel into the Statistical Package for the School Sciences (SPSS).

ANALYSIS AND DISCUSSION

Demographic Background

Data on the demographic background were gained to gather personal information of the samples. In connection with Table 1, only respondents aged over 21 years old were included in the study. The highest respondents answering the questionnaire aged ranging from 27 to 36 years old at 43% for both consultants and contractors. At the same time, 3% of the respondents aged above 56 years old which marked off as the lowest number of respondents. In terms of years of experience in the construction industry, most of the respondents were involved in the construction industry for more than 2 years and the least were 8.1% of fresh graduates. Indefinitely, it was a remarkable sample ensemble to answer the questionnaire from a different demographic background on the age and experience of working in the construction industry with the majority held by the experienced respondents.

Table 1: Demographics of Respondents

Organisation	Age	Experience in Construction Industry (Years)					Frequency (Age)
		0 - 1	2 - 5	6 - 10	11 - 20	> 20	
Consultant	21 - 26	6	6	0	0	0	**12**
	27 - 36	0	11	17	5	0	**33**
	37 - 46	0	0	4	11	3	**18**
	47 - 56	0	0	0	0	15	**15**
	> 56	0	0	0	0	3	**3**
Contractor	21 - 26	2	11	1	0	0	**14**
	27 - 36	3	9	13	0	0	**25**
	37 - 46	0	0	1	8	1	**10**
	47 - 56	0	0	0	2	2	**4**
	> 56	0	0	0	0	1	**1**
Frequency (Experience)		**11**	**37**	**36**	**26**	**25**	**135**

Level of Education, Organisation, Profession and Current Position

The profession of the respondents discrete to nine different backgrounds as shown in Table 2. Amongst the higher number of respondents work as an Engineer, Architect and Quantity Surveyor which these three professions were the main stakeholders in managing construction projects both as consultants as well as contractors. at 89.6% of the sample. The respective Engineers, Architects and Quantity Surveyors mostly held academic qualifications with Bachelor Degree which was the minimum requirement to sit for a professional assessment. Fifteen Engineers, Architects and Quantity Surveyors who work with consultants were qualified professionals in their profession of which three numbers of the contractors from the same group of the profession also have a professional qualification. It can be measured at a percentage of 20.3% and 6.4% of the overall population of each type of organisation. Including professionals as respondents adding extra reliability and validity to the data. A percentage of more than 20% of the whole contractors' sample population were positioned not lower than middle management level in their organisation. While almost 40% of consultants were managers, managing directors, directors and principals of the organisation they were working with. Response from the top and middle management levels were important as they made the most decisions in the management of construction projects within an organisation not to mention they had more experience and knowledge on the matter of the study.

Table 2: Background and Occupational Information of Respondents

Organisation	**Level of Education**	**Profession**									
		Architect	**Claim Manager**	**Engineer**	**Interior Designer**	**Land Surveyor**	**Landscape Architect**	**Planner**	**Project Manager**	**Quantity Surveyor**	**Frequency (Education)**
Consultant	Diploma	2	0	0	0	0	0	0	0	4	**6**
	Bachelor Degree	22	0	13	0	1	2	1	0	10	**49**
	Bachelor Degree and Professional (Ar/ Ir/ Sr/ Ts etc)	8	0	5	0	0	0	0	0	0	**13**
	Master Degree	4	0	3	1	0	1	0	0	1	**10**
	Master Degree and Professional (Ar/ Ir/ Sr/ Ts etc)	0	0	0	0	0	0	0	0	2	**2**
	PhD and Professional (Ar/ Ir/ Sr/ Ts etc)	0	1	0	0	0	0	0	0	0	**1**
	Frequency (Profession)	**36**	**1**	**21**	**1**	**1**	**3**	**1**	**0**	**17**	**81**
Contractor	Diploma	2	0	4	0	0	0	0	1	1	**8**
	Bachelor Degree	2	0	16	0	0	0	2	2	11	**33**
	Bachelor Degree and Professional (Ar/ Ir/ Sr/ Ts etc)	0	0	1	0	0	0	0	0	1	**2**
	Master Degree	0	0	4	0	0	0	2	0	4	**10**
	PhD, Professional (Ar/ Ir/ Sr/ Ts etc)	0	0	1	0	0	0	0	0	0	**1**
	Frequency (Profession)	**4**	**0**	**26**	**0**	**0**	**0**	**4**	**3**	**17**	**54**

In total, just below half the sample (40%) were contractors, of whom 60% were consultants. It was acceptable because a construction project commonly awards to only one main contractor with or without a nominated subcontractor. Before the award, at least two consultants were appointed for one particular construction project to design, get approval for the design, consult and coordinate the work. Aside from it, respondents may have been working with both types of organisations during their period of practice.

The Communication Methods Commonly Used in Construction Projects during Construction Phase between Consultants and Contractors

This section sought for the frequency of communication modes and mediums commonly practised by consultants and contractors exceptionally during the construction phase. The result had revealed insight into the everyday routines of each respondent in managing construction projects. The mediums were divided by mode (verbal, written, and visual) in this questionnaire.

Table 3: Communication Mode and Medium – Verbal

Mode	Code	Communication Medium	Mean (Variable)	Ranking (Variable)	Overall Mean	Overall Ranking
Verbal	B1A	Formal meeting	4.06	1	3.52	5
	B1C	Formal discussion	3.96	2		7
	B1D	Telephone-conversation	3.96	2		7
	B1F	Informal chat	3.70	3		13
	B1B	Presentation	3.31	4		18
	B1E	Video conference	2.10	5		24

Table 3 registered measurement made to the verbal communication mode and medium commonly used by consultants and contractors during the construction phase. It appeared that formal meeting evidence was the highest means for verbal communication by consultants and contractors during the construction phase. Meanwhile, the lowest mean was served by video-conference. A formal meeting in this framework was a pre-planned event that encompasses a technical meeting, site meeting, kick-off meeting and any form of a meeting held on during the construction phase. The event presented by many parties to the construction project including consultants and contractors which usually adhere at the interval of fortnightly to one (1) month. Communication during the construction phase was the most compelling when cost and time were crucial. That must be the reason why face-to-face meeting in the form of the formal meeting was commonly used during the construction phase for a clearer picture of the construction project's matter and faster decision-making. In addition, a formal meeting was a two-way form of communication.

Table 4: Communication Mode and Medium – Written

Mode	Code	Communication Medium	Mean (Variable)	Ranking (Variable)	Overall Mean	Overall Ranking
Written	B2B	Electronic mail	4.24	1	3.74	1
	B2K	Social media (i.e. WhatsApp etc)	4.19	2		2
	B2F	Progress report	4.07	3		4
	B2J	Specification	3.98	4		6
	B2H	Minutes of meeting	3.96	5		7
	B2I	Bills of quantity	3.91	6		8
	B2M	Request For Information (RFI)	3.87	7		9
	B2L	Instruction (AI, EI)	3.84	8		10
	B2G	The standard form of contract	3.74	9		11
	B2D	Letter	3.72	10		12
	B2N	Method Statement	3.70	11		13
	B2O	Quotation	3.70	11		13
	B2A	Short Message Services (SMS)	2.98	12		16
	B2E	Memo	2.98	12		21
	B2C	Facsimile	2.67	13		22

As of written mode featured in Table 4, about 4.24 mean of respondent rate for electronic mail means it was the commonly used medium for communication during the construction phase. Social media like WhatsApp and progress reports follow behind. The so-called technology advancement of medium was probably selected because both electronic social media were fast and easy to use. Meantime, the progress report was a compulsory medium in every site meeting which usually held at the interval of fortnightly to one month. It was prepared progressively for every site meeting, becoming a reference to construction project teams to review the progress of physical work, the progress of project financial and problem arisen on site. That would be the reason why progress report had been used commonly by respondents.

Table 5: Communication Mode and Medium – Visual

Mode	Code	Communication Medium	Mean (Variable)	Ranking (Variable)	Overall Mean	Overall Ranking
Visual	B3A	Drawing	4.12	1	3.42	3
	B3F	Pictures	3.87	2		9
	B3G	Catalogue	3.62	3		14
	B3B	Sketch	3.58	4		15
	B3E	Sample	3.44	5		17
	B3H	Physical mock-up	3.19	6		19
	B3C	3D perspective	3.04	7		20
	B3D	Physical model	2.50	8		23

From the delineation in Table 5 above, drawing was the most favourable for the visual mode of communication amongst respondents. In a construction project especially during the construction phase, drawing was supposed to be presented. Otherwise, construction work could not commence on-site and no coordination of work amongst consultants and contractors possible to happen. Pictures were selected as the second-highest visual mode of communication presumably to provide updates, show the progress of work on-site, highlight construction work that needs rectification and become a reference in the decision-making process. Correlated to the entire result for communication mode and medium, rating from the mean demonstrated that written mode of communication was at the top with electronic mail and social media as the commonly used medium for communication between consultants and contractors during the construction phase and the video-conference was rated at the bottom of communication medium. Nevertheless, the lowest mean of commonly used communication were the visual mode of communication. On the subject of communication modes and mediums commonly used during the construction phase between consultants and contractors, respondents for the questionnaire survey had chosen the easiest and fastest way to convey a message and/ or information even though the channel was informal. The highest mean of communication mode was written over verbal and visual with eight (8) over ten (10) of variables for communication medium were discriminating from the written mode of communication.

Factors Contributing to Communication Breakdown during Construction Phase between Consultants and Contractors

The result in Table 6 below indicated that 'project characteristic' position at an average in comparison to the other category of contributing factors to communication breakdown. Based on the answer received from most recipient for the category of project characteristic, the highest mean represented by 'changes in decision making'.

Table 6: Factors Contributing to Communication Breakdown – Project Characteristic

Category	Code	Factors Contributing to Communication Breakdown	Mean (Variable)	Ranking (Variable)	Overall Mean	Overall Ranking
Project Characteristic	C1F	Changes in decision making	3.90	1	3.50	1
	C1F	Inappropriate planning of project communication	3.79	2		2
	C1E	Unclear or changes in project objectives	3.71	3		4
	C1G	Tensions of the job	3.41	4		17
	C1D	Unique attributes of project	3.39	5		18
	C1A	Project Brief	3.36	6		19
	C1B	Project duration or lifecycle	3.25	7		23
	C1C	Location of the project site	3.15	8		24

'Project characteristic' basically defined by the client to the project or project developer but the decision certainly gave effect to other construction parties containing consultants and contractors. In the context of this study, 'changes in decision making' occurred after the construction contract had been bound between construction parties. The reasons behind the changes were indefinite and some of it were unavoidable such as natural incidents or new requirement implemented by statutory bodies had to be complied. The client may change their decision due to the new evolution of construction methods or materials which could contribute to the reduction of construction cost. Higher selection of 'inappropriate planning of project communication' exhibited that proper planning was required for project communication. It should be designed to suit the 'project characteristic'. The inappropriateness had caused the delivery of the wrong type of information. Most respondents vote that 'location of project site' and 'project duration or lifecycle' do not cause a communication breakdown.

'Personal attitude' was among the reason why work on-site was not constructed according to the drawing or instruction. The highest rank of reasons as preferred by respondents advertised in Table 7 was 'lack of checking information' and 'poor leadership'. There were cases where contractors made own assumption on the construction method for some of the work without checking on the information provided in the drawings or any kind of communication medium. Consequently, the work was erected according to the way they normally practice rather than referring to the details provided in the drawing.

Table 7: Factors Contributing to Communication Breakdown – Personal Attitude

Mode	Code	Factors Contributing to Communication Breakdown	Mean (Variable)	Ranking (Variable)	Overall Mean	Overall Ranking
Personal Attitude	C2D	Lack of checking information	3.79	1	3.60	2
	C2G	Poor leadership	3.72	2		3
	C2A	Difference experience level	3.68	3		5
	C2C	Different interpretation or perception	3.67	4		6
	C2H	Afraid to ask for clarification	3.66	5		7
	C2E	Poor listener	3.57	6		12
	C2B	Lack of mutual respect	3.53	7		13
	C2F	Sense of self-importance	3.51	8		14
	C2I	Anger or temper issue	3.27	9		22

Leadership was the essence of project management so it was apparent that ‘poor leadership’ contributes to communication breakdown. Very few of respondents had chosen ‘anger or temper issue’ as the factors to communication breakdown as the construction industry was a professional field whereby construction parties were bound by the stipulated contract and agreement for the construction work. Therefore, there was a limitation on their action. The parties just cannot keep with the anger to warrant work keep going on and to keep a good relationship for the future construction job. ‘Sense of self-importance’ also related to professionalism and less elected by the respondents.

Under the ‘communication method’ and ‘communication management’ in connection with Table 8, ‘poor documentation’ and ‘insufficient information’ were the reason for communication breakdown. On the ground that construction project was highly fragmented, multidisciplinary and involve multiple organisations, it was a priority to communicate clearly, specifically, sufficiently and accurately. ‘Poor documentation’ can be interpreted as a situation that failed to send a message or information and ‘insufficient information’ was a condition of a message was sent incompletely which consequencetly failed to result in accurate action. The literature said this situation would mean the respective party had less intention to share their information.

Table 8: Factors Contributing to Communication Breakdown – Communication Method and Communication Management

Mode	Code	Factors Contributing to Communication Breakdown	Mean (Variable)	Ranking (Variable)	Overall Mean	Overall Ranking
Communication Method	C3B	Poor documentation	3.60	1	3.32	10
	C3C	Inadequate writing skills	3.46	2		16
	C3A	Informal communication	3.36	3		19
	C3D	Inappropriate visualisation technique	3.33	4		20
	C3E	Misunderstanding of body language	2.87	5		28
Communication Management	C4B	Insufficient information	3.65	1	3.59	8
	C4D	Timing of information	3.64	2		9
	C4C	Unrealistic goals of promises	3.59	3		11
	C4A	Ineffective communication during the pre-construction phase	3.47	4		15

The construction industry was likely to use specialised content or technical terms that could be the reason for mean for the factor stated in Table 9 was higher as part of the 'communication barrier' category. Results from the questionnaire set out that 'adversarial or opposing cultures' at the lowest fourth. It seems that Malaysia itself drew on the varied cultures of the different people. The result of this study was in contrast to previous literature from countries other than Malaysia that had recorded 'communication barrier' was amongst the most significant category of communication breakdown to the respective countries.

Table 9: Factors Contributing to Communication Breakdown – Communication Barrier and External Aspect

Mode	Code	Factors Contributing to Communication Breakdown	Mean (Variable)	Ranking (Variable)	Overall Mean	Overall Ranking
Communication Barrier	C5D	Technical language	3.32	1	3.11	21
	C5C	Ethical consideration	3.08	2		25
	C5B	Language challenges	3.07	3		26
	C5A	Adversarial cultures (opposing cultures)	2.96	4		27
Ex	C6C	Political interference	3.08	1		25

C6B	Physical distance or interruption	2.84	2	2.90	29
C6A	The noisy environment during communication	2.79	3		30

The highest rank of factors external aspect' was 'political interference' and it was an intractable issue. Construction projects principally related to government presumably siding this problem upon a presidential political election. In outward, 'noisy environment during communication' was least compelling on account of the environment during communication was controlled by the parties involved in the communication. The environment was not fixed and subject to the preference of the parties. It was changeable in so much as a suitable place for communication can be chosen or suggestion for change of venue can be made if the environment was a nuisance.

Results of the questionnaire survey indicated that the respondents on average agreed on all of the contributing factors as listed in the questionnaire survey had caused communication breakdown during the construction phase between consultants and contractors. The top 2 factors were variables under the category of 'project characteristic' which were 'changes in decision making' and 'inappropriate planning of project communication'. In general, the findings delineated 'personal attitude' as the main contributor to the communication breakdown with the highest mean of 3.60. Through the questionnaires, the respective category had dominated 5 of the top 10 variables to the factors contributing to communication breakdown during the construction phase between consultants and contractors. In contrast, most literature identified different interpretations and perceptions (under 'personal attitude') as the contributing factors to communication breakdown. In terms of category, 'communication method' and 'communication barrier' were the most significant category of contributing factors recorded in previous studies. This meant that individual behaviour gave the main influence on communication. Communication can only occur when an individual had the will to convey it.

Communication Initiatives to Minimise Communication Breakdown during Construction Phase between Consultants and Contractors to Achieve Project Success

In terms of 'communication development', the respondents rank 'encourage teamwork amongst project team' in Table 10 as rather effective to minimise communication breakdown than 'attend leadership training'. The selection was aligned with literature that declared on the involvement of teamwork was required in construction projects due to its unique characteristics. Literature also acknowledged communication in construction projects could be improved by enhancing teamwork amongst multidisciplinary parties of construction work. In the meantime, the result reported for the 'attend leadership training' was in parallel to the literature likewise. The literature explicated that training initiatives were in need to focus on the improvement of communication and cooperation or teamwork instead of leadership.

Table 10: Initiatives to Minimise Communication Breakdown – Communication Development.

Mode	Code	Initiatives To Minimise Communication Breakdown	Mean (Variable)	Ranking (Variable)	Overall Mean	Overall Ranking
Communication Development	D1B	Encourage teamwork among project team	4.04	1	3.83	9
	D1A	Familiarise with the project's characteristics, project's context and project's contract	3.96	2		11
	D1C	Encourage communication willingness among project team	3.96	2		11
	D1D	Attend training in communication and cooperation management	3.64	3		20
	D1E	Attend leadership training	3.53	4		22

The long tabulation of initiatives under the 'communication management' of Table 11 documented that 'communication promptly for critical information', 'making an accurate decision' and 'contractors to communicate if they need further project information on time' were the top initiatives. It can be seen that respondents agree the time was a concern in managing a construction project. In the construction industry, time was money and prompt communication enable to prevent delay, incurrence in mistake and abortive work which eventually devote additional cost to the construction project. Making effective and accurate decisions unmistakably result in a positive outcome. In this matter, it was the initiatives by consultants and contractors to give accurate, clear, specific and sufficient advice for the ultimate decision-making by the client or developer. It could also be a decision made by consultants who were appointed to represent the client during the construction phase.

Table 11: Initiatives to Minimise Communication Breakdown – Communication Management

Mode	Code	Initiatives To Minimise Communication Breakdown	Mean (Variable)	Ranking (Variable)	Overall Mean	Overall Ranking
Communication Management	D2K	Communicate promptly for critical information	4.27	1	3.98	1
	D2N	Making accurate decision	4.20	2		2
	D2E	Contractors to communicate if they need further project information on time	4.16	3		3
	D2I	Re-communicate on any matter that cannot be understood	4.13	4		4
	D2J	Document all communication to reduce mistakes	4.13	4		4
	D2G	The coordinate sequence of work throughout the construction period	4.11	5		5
	D2H	Reach to an agreement for any communication dispute	4.09	6		7
	D2M	Having a regular meeting or ongoing discussion	3.90	7		12
	D2C	Exchanging contact information during site possession	3.88	8		13
	D2D	Consultants to fully delegate their design to contractors before the date of commencement	3.88	8		13
	D2A	Establish appropriate and timely communication that meets the client's requirement	3.85	9		15
	D2F	Select decision-maker among stakeholders	3.87	10		14
	D2L	Avoid communication in a noisy environment	3.64	11		20
	D2B	Develop and use communication plan or model	3.61	12		21

'Communicate to the right person' and 'practice two-way of communication rather than one-way of communication' in initiating to minimise communication breakdown distinctively bring productive effect to the communication between consultants and contractors. Message sending to the right person was undeniably effective and it was efficient to practice two-way communication hence responses were given to achieve mutual understanding and consensus between the parties. The result of the questionnaire for Table 12 above was not taking priority for the 'requesting and exchanging project information in face-to-face approach' along with 'set up visual and physical mock-up unit'.

These actions perhaps would not give a big impact on the minimisation of communication breakdown between consultants and contractors despite literature had expounded on these matters. It could be the reason that finding time for a face-to-face approach was difficult and it was not possible to be held immediately. It can be summarised that the most effective category of initiative elevated by respondents was 'communication management' with 'communicate promptly for critical information' had the highest mean.

Table 12: Initiatives to Minimise Communication Breakdown – Communication Method

Mode	Code	Initiatives To Minimise Communication Breakdown	Mean (Variable)	Ranking (Variable)	Overall Mean	Overall Ranking
Communication Method	D3C	Communicate to the right person	4.10	1	3.88	6
	D3F	Practice two-way communication rather than one-way communication	4.05	2		8
	D3H	Use various communication mediums (i.e. drawing, letter, meeting)	4.02	3		10
	D3E	Use all modes of communication (verbal, non-verbal, written, visual)	3.87	4		14
	D3G	Use formal communication channel rather than informal channel	3.80	5		16
	D3D	Use of visual communication (i.e. pictorial)	3.76	6		17
	D3B	Set up visual and physical mock-up unit	3.73	7		18
	D3A	Requesting and exchanging project information in a face-to-face approach	3.70	8		19

It was a strong argument with the top 6 variables selected by respondents of the questionnaire survey was within the category of 'communication management'. Results of the questionnaire survey for the second and third rank of initiatives to minimise communication breakdown. The collective suggestion from literature reported that consultants and contractors shall be friendly and flexible to each other. Rather than finger-pointing, they should be responsible for their work, coordinate their drawings, communication and work in a team. Most literature instead suggests to 'develop and use of communication plan and model' and implement effective 'communication method' to minimise communication breakdown. The finding of this study particularly to this research question was not consistent with the previous studies. It shows that construction parties who work in Malaysia look for enhancement in the element of 'communication management' to minimise communication breakdown during the construction phase between consultants and contractors.

CONCLUSION

In conclusion, matters relating to communication between consultants and contractors during the construction phase with commonly used communication methods were investigated, contributing factors to communication breakdown were identified and actions to minimise the communication breakdown were also suggested. Most importantly, project success can be achieved with the improvement of communication between consultants and contractors during the construction phase by the implementing action as suggested herewith. This study could provide the construction parties to get an in-depth understanding of the communication methods available within the construction industry for the application. The study will be able to encourage respective construction parties to be willing to communicate for the improvement to achieve project success. The construction players probably would start to notify their flaws and taking the initiatives actions for the improvement of their performance.

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INFLUENCE OF REGIONAL TRANSPORT ACCESSIBILITY ON DEVELOPMENT OF SETTLEMENTS: A CASE OF VISAKHAPATNAM REGION

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Abstract

The evolution of road development started with the idea of connecting metropolitan cities with the surrounding region. “All roads lead to Rome” which also shows us that, urban development attracts transport infrastructure. But eventually, settlements started to evolve in close proximity to the roads, which shows that development is followed by a transportation network. This has led to a common debate on what should come first, Opportunities/Settlement or Transport Infrastructure. In view of the existing literature, the interdependency of Regional Development and Transport Infrastructure can be classified under three categories which are 1. Transport system (Infrastructure) follows regional development, 2. Infrastructure development as an inductor of regional development and 3. Equality in development emphasizes balanced economic growth and infrastructure in a region. (Botrić, Šišinački and Škuflić, 2006). This study is an attempt to understand the development of the Visakhapatnam district in a regional context and its relation to the regional transportation network. The relationship between the accessibility of regional transport at the nodal level and the development of major settlements has been studied for the same. After analyzing various indicators of development and transportation infrastructure, an impact assessment of two indicators has been done. One of the indicators to study development is the growth rate in terms of the population of the Visakhapatnam region and the indicator to study transport accessibility is Shimbel’s index of major nodes in the regional network. The Geographic Information System has been used as a tool to develop the Road network and to generate the initial connectivity matrix for calculating the Shimbel Index. After obtaining the data related to the indicators of regional development and transportation accessibility, regression analysis has been performed which shows the relationship between the development of major settlements and accessibility.

Keyword: Nodal Accessibility, Shimbel Index, Detour Index, Regional Transport Network, Regression Analysis

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INTRODUCTION

The regional transport network is a web of networks connecting different settlements with other major settlements or CBD areas. This network should be designed such that it becomes accessible to other important nodes in a region. To understand the study well we have taken another south Indian city which is Calicut, so to evaluate the connection and spatial pattern of Calicut's Road network and also to find out whether the network connectivity of a region can explain the geographical pattern of the network structure. The research area's connection and coverage are directly related to the fractality of the transportation network, according to the analysis. Any other connection metric could not predict the fractality of the road network as well as network density. This suggests that the quantity of road network expansion and the geographical structure of the network inside the study region are strongly linked. (Sreelekha, Krishnamurthy and Anjaneyulu, 2016).

LITERATURE REVIEW

Road infrastructure is critical to a region's growth since it provides connectivity, accessibility, and appeal to all adjacent regions. Developers are attracted to these so-called "greenfield sites" because land prices are lower than in the city centre, land assembly is simpler, development expenses are lower, the locations are vehicle accessible, and the environmental quality is believed to be good. Unsurprisingly, investment in new roads outside of city centres has improved the accessibility of property with cheap rates and boundary ROW, putting significant strain on the new roadways. (Transport investment and economic development, 1967) (Singh, 2021)

Highways and airports have been proven to have a crucial role to promote development in an area and population expansion, according to research. The findings demonstrate that the impacts differ between the three types of areas. Population growth in rural areas is increased by making improvements in the Highway network and enhancing the accessibility of airports; The population growth in suburban areas is accelerated by enhancing airport accessibility, but population flows are supplemented by highway accessibility, and neither of both seems to affect changes in growth rates of and population of urban areas. (Chi, 2012)

Table 8: Literature Review

Sl.no	Title	Parameters	Conclusion
1	Analyzing the Dynamic Relationships between Physical Infrastructure, Financial Development and Economic Growth in India By Ranjan Kumar Mohanty -2019	Physical Infrastructure Index, GPD, Employment and Financial Development Index	There is significant impact on economic growth due to improvement of physical infrastructure.

2	Impact of Social Infrastructure and Physical Infrastructure on Economic Growth in Punjab, India By Jagmohan Singh – 2021	District-level Social Infrastructure Index, Physical Infrastructure index and Economic growth.	Physical infrastructure has a major importance in accelerating economic development in Punjab whereas the situation is not same in case of Social infrastructure.
3	Road Infrastructure and Regional Development : An Evidence from Croatia By Valerija Botric -2006	Road network, Average Annual Daily Traffic (AADT), Travel Time, Travel Speed, Employment, Tourism and GDP growth	An increase in road network has a direct positive impact on employment generation and tourism and thus has a positive impact on regional development.

Source: (Bhanumurthy, 2019) (Singh, 2021) (Valerija Botric, 2006)

Accessibility

Accessibility is the term used in urban, regional and rural transport planning and Lanusse studies. Accessibility is generally defined as 'Ease of Reaching'. It can be measured with respect to location, modes of transport and time period. In this study we will be measuring the accessibility of locations at nodal levels.

Quantification of Accessibility

For studying a transportation network graph theory suggest various measures to quantify the connectivity and accessibility levels as follows.

Shimbel Index

The Simbel index determines the smallest number of routes essential for connecting one given node to all the other nodes in a transport network. The Shimbel accessibility matrix, known as the D-Matrix, shows the shortest path between each conceivable node pair. Basic and extremely practical metric, characterized as prospective accessibility, may be derived from the accessibility measure presented. The lower the value, the more accessible a location is.

Detour Index

The detour index calculates the accessibility of towns in a network based on the shortest distance or straight-line distance between them. It is a metric for determining the effectiveness of a transportation network based on how well it minimises distance or friction of distance. As the detour index approaches 1, the network becomes more spatially efficient. The Detour value between two places in a network is given by the following formula.

Detour Value in % = (Actual Distance in Km)/(Straight Line Distance in Km)*100

RESEARCH METHOD

The following method of data collection and technical analysis was used. In order to perform a significant analysis and to develop a relationship Vishakhapatnam region was studied at the settlement/nodal level, the minimum number of links used to connect one settlement to all other nodes is noted, this was done using GIS and Google Earth. After data generation, it was refined in D-Matrix using Ms-Exel. Shimbel index values were recorded. One of the key factors of development is population, so in the analysis populations and population growth rate has been used to develop a relationship. Population data from the last 20 years (i.e from 1991-2011) has been taken from census records. Finally, Co-relation and simple regression have been carried out, to find out the significance of relationship between them.

STUDY AREA

Visakhapatnam is one of the coastal districts located on the Bay of Bengal coast in the state of Andhra Pradesh which is one of the southern states of India. It is one of the important regions because of its transport connectivity. The National Highway 16 (Kolkata to Chennai) passes through the city, Visakhapatnam–Chennai Industrial Corridor (VCIC) is aligned with the Golden Quadrilateral of India. It has a port with a strategic benefit of a natural harbour and the city is the headquarters of the Eastern Naval Command of the Indian navy. It is also referred to as States Financial Capital. It is one of the major tourist attractions in the state with a sea coast, eastern ghats and hill stations like Araku, Paderu etc.

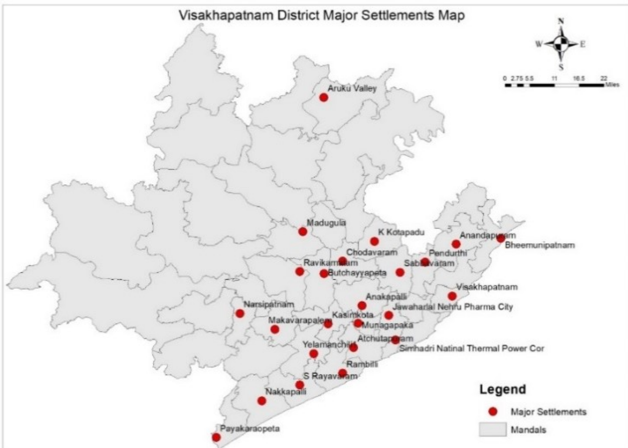

Figure 1: Map of Major settlements of Visakhapatnam district
Source: Produced by author

ANALYSIS

To understand the relationship between development and transport accessibility the data related to indicators which are urban population growth rate and shimbel's index for development and population respectively need to be analyzed for each settlement in the network.

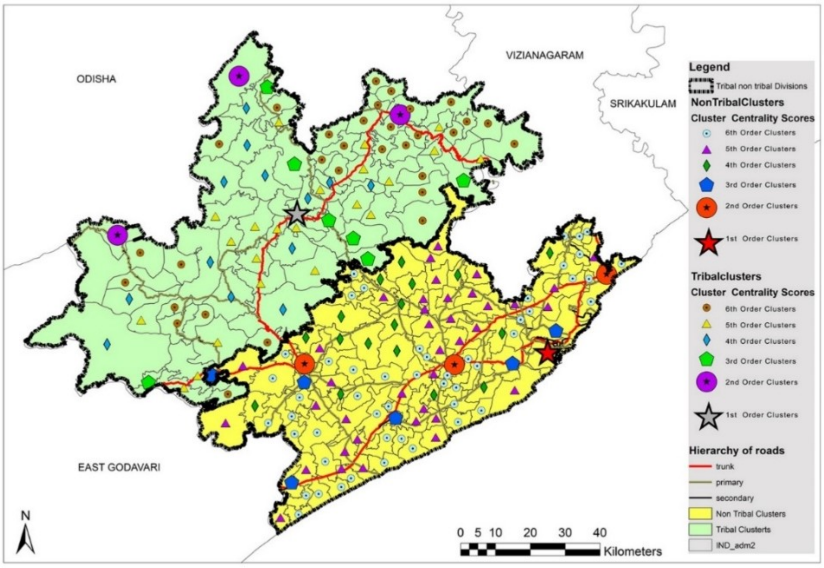

Figure 2: Development map of Visakhapatnam district
Source: Produced by author

Calculation of Population Growth Rate

As the decadal population growth rate is considered an indicator of regional development. The population data of all the settlements are collected from the Census of India – Primary Census abstract and the decadal growth rate can be calculated using the following formula.

$$Decadal\ Population\ Growth\ Rate = \frac{\Delta P}{Pf}$$

ΔP = (P_f – P_0) = (Final – Initial Population)/Decadal Change in Population
P_f = Population of (n+1)th Decade P_0 = Population of Initial (nth) Decade

Calculation of Shimbel Index

Shimbel Index: Shimbel Index is a measure of accessibility among the nodes in a network which are settlements in this case. In the shimbel index, we have an original connectivity matrix (C – Matrix) and Shimbel Matrix (D-Matrix). The original connectivity matrix represents value "1" for cells where origin "i" and destination "j" are directly connected with each other and value "0" for the cells where origin "i" and destination "j" are not directly connected by a single link.

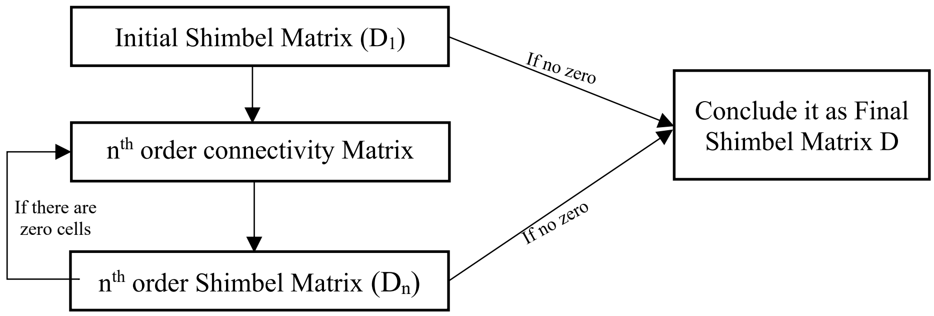

Figure 3: Flow Chart Showing calculation of Shimbel Matrix
Source: Prepared by Author

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1		Anandap	Pendurt	Sabbava	Bheemun	Jawaha	Simhadri	K Kotapa	Chodavar	Butchayy	Anakapalli	Atchutapu	Munagapa	Rambilli	Kasimkc	Madugul	Ravikam	Makavar	Yelaman	S Raya	Aruku V	Narsipat	Nakkapa	Payakarac	Visakhap	0
2	Anandapuram	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
3	Pendurthi	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	5
4	Sabbavaram	0	1	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6
5	Bheemunipatnam	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
6	Jawaharlal Nehru Pharma City	0	0	1	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	6
7	Simhadri Natinal Thermal Power	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	5
8	K Kotapadu	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
9	Chodavaram	0	0	1	0	0	0	1	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	6
10	Butchayyapeta	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3
11	Anakapalli	0	0	1	0	1	1	0	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	7
12	Atchutapuram	0	0	0	0	1	1	0	0	0	0	0	1	1	1	0	0	0	1	0	0	0	0	0	1	7
13	Munagapaka	0	0	0	0	1	1	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	1	6
14	Rambilli	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
15	Kasimkota	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	1	1	0	0	0	0	0	0	5
16	Madugula	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	4
17	Ravikamatam	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	3
18	Makavarapalem	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	2
19	Yelamanchili1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	1	0	0	4
20	S Rayavaram	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	2
21	Aruku Valley	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	3
22	Narsipatnam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	0	4
23	Nakkapalli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	4
24	Payakaraopeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
25	Visakhapatnam	1	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	8
26	0	3	5	6	2	6	5	3	6	3	7	7	6	1	5	4	3	2	4	2	3	4	4	1	8	0

Figure 4: Original Connectivity Matrix C1
Source: Prepared by Author

From the Initial Shimbel matrix (D_1) it can be observed that 452 cells have a "0" value which means all the corresponding origins and destinations of these cells are not directly connected to each other with one link.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1												D1													
2	Anandapuram	0	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
3	Pendurthi	1	0	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
4	Sabbavaram	-	1	0	-	1	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
5	Bheemunipatnam	1	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
6	Jawaharlal Nehru Pharma City	-	-	1	-	0	1	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	1
7	Simhadri Natinal Thermal Power Cor	-	-	-	-	1	0	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	1
8	K Kotapadu	-	1	1	-	-	-	0	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	Chodavaram	-	-	1	-	-	-	1	0	1	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-
10	Butchayyapeta	-	-	-	-	-	-	-	1	0	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
11	Anakapalli	-	-	1	-	1	1	-	1	1	0	-	1	-	1	-	-	-	-	-	-	-	-	-	-
12	Atchutapuram	-	-	-	-	1	1	-	-	-	-	0	1	1	1	-	-	-	1	-	-	-	-	-	1
13	Munagapaka	-	-	-	-	1	1	-	-	-	1	1	0	-	1	-	-	-	-	-	-	-	-	-	1
14	Rambilli	-	-	-	-	-	-	-	-	-	-	1	-	0	-	-	-	-	-	-	-	-	-	-	-
15	Kasimkota	-	-	-	-	-	-	-	-	-	1	1	1	-	0	-	-	1	1	-	-	-	-	-	-
16	Madugula	-	-	-	-	-	-	-	1	1	-	-	-	-	-	0	1	-	-	-	1	-	-	-	-
17	Ravikamatam	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0	-	-	-	-	1	-	-	-
18	Makavarapalem	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	0	-	-	-	1	-	-	-
19	Yelamanchili1	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	0	1	-	-	1	-	-
20	S Rayavaram	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	-	-	1	-	-
21	Aruku Valley	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	0	1	-	-	-
22	Narsipatnam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1	0	1	-	-
23	Nakkapalli	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	1	0	1	-
24	Payakaraopeta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	-
25	Visakhapatnam	1	1	1	1	1	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	0

Figure 5 : Initial Shimbel Matrix (D_1)
Source: Prepared by Author

So, this cannot be the final shimbel matrix and we have to calculate the nth order connectivity matrix and replace the additional non-zero values till we get no zeros in the D-matrix.

The nth-order C-Matrix (C_n) is given by

$$Cn = C1 * C(n-1)$$

C_1 = Original Connectivity Matrix and $C_{(n-1)}$ = $(n-1)^{th}$ order connectivity Matrix

Iteration 1

	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU
29																									
30													C2												
31																									
32	Anandapura	3	1	2	1	1	1	1	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	2
33	Pendurthi	1	5	2	2	2	1	1	2	0	1	1	1	0	0	1	0	0	0	0	0	1	0	0	2
34	Sabbavaram	2	2	6	1	2	3	2	2	2	2	2	3	0	1	1	1	0	0	0	1	0	0	0	2
35	Bheemunipa	1	2	1	2	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1
36	Jawaharlal N	1	2	2	1	6	4	1	2	1	3	3	4	1	3	0	0	0	1	0	0	0	0	0	4
37	Simhadri Na	1	1	3	1	4	5	0	1	1	2	3	4	1	3	0	0	0	1	0	0	0	0	0	3
38	K Kotapadu	1	1	2	0	1	0	3	1	1	2	0	0	0	0	1	1	0	0	0	1	0	0	0	2
39	Chodavaram	0	2	2	0	2	1	1	6	2	2	0	1	0	1	2	1	0	0	0	1	1	0	0	1
40	Butchayyap	0	0	2	0	1	1	1	2	3	1	0	1	0	1	1	2	0	0	0	1	0	0	0	0
41	Anakapalli	0	1	2	0	3	2	2	2	1	7	4	3	0	1	2	1	1	1	0	0	0	0	0	4
42	Munagapaka	1	1	2	1	3	3	0	0	0	4	7	4	0	2	0	0	1	1	1	0	0	1	0	3
43	Rambilli	1	1	3	1	4	4	0	1	1	3	4	6	1	2	0	0	1	2	0	0	0	0	0	3
44	S Rayavarar	0	0	0	0	1	1	0	0	0	0	0	1	1	1	0	0	0	1	0	0	0	0	0	1
45	Kasimkota	0	0	1	0	3	3	0	1	1	1	2	2	1	5	0	0	0	1	1	0	1	1	0	2
46	Madugula	0	1	1	0	0	0	1	2	1	2	0	0	0	0	4	1	0	0	0	0	2	0	0	0
47	Ravikamatan	0	0	1	0	0	0	1	1	2	1	0	0	0	0	1	3	1	0	0	2	0	1	0	0
48	Makavarapal	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	2	1	0	1	0	1	0	0
49	Yelamanchili	0	0	0	0	1	1	0	0	0	1	1	2	1	1	0	0	1	4	1	0	1	1	1	1
50	S Rayavarar	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	2	0	1	1	1	0
51	Aruku Valley	1	0	1	0	0	0	1	1	1	0	0	0	0	0	0	2	1	0	0	3	0	1	0	1
52	Narsipatnam	0	1	0	0	0	0	0	1	0	0	0	0	0	1	2	0	0	1	1	0	4	0	1	0
53	Nakkapalli	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	1	1	1	1	0	4	0	0
54	Payakaraop	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0
55	Visakhapatn	2	2	2	1	4	3	2	1	0	4	3	3	1	2	0	0	0	1	0	1	0	0	0	8

Figure 6 : 2^{nd} Degree Connectivity matrix (C_2)
Source: Prepared by Author

Using the formula for the n^{th}-order C-Matrix to obtain the 2^{nd} order C-Matrix we get $C_2 = C_1 * C_1$

By performing the matrix multiplication for C1 Matrix we get the resultant C_2 matrix as shown in fig 5. Now we have to identify the non-zero cells in C_2 which have a "0" value in D_1 and replace them with "2" as they are filled in a second-degree connectivity matrix Thus, we obtain an updated shimbel matrix D_2 as shown below in Fig 7.

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
81	D2 Matrix																							
82																								
83	2	1	2	1	2	2	2	-	-	-	2	2	-	-	-	-	-	-	-	2	-	-	-	1
84	1	2	1	2	2	2	1	2	-	2	2	2	-	-	2	-	-	-	-	1	2	-	-	1
85	2	1	2	2	1	2	1	1	2	1	2	2	-	2	2	2	-	-	-	2	-	-	-	1
86	1	2	2	2	2	2	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	1
87	2	2	1	2	2	1	2	2	2	1	1	1	2	2	-	-	-	2	-	-	-	-	-	1
88	2	2	2	2	1	2	-	2	2	1	1	1	2	2	-	-	-	2	-	-	-	-	-	1
89	2	1	1	-	2	-	2	1	2	2	-	-	-	-	2	2	-	-	-	2	-	-	-	2
90	-	2	1	-	2	2	1	2	1	1	-	2	-	2	1	1	-	-	-	2	2	-	-	2
91	-	-	2	-	2	2	2	1	2	1	-	2	-	2	1	2	-	-	-	2	-	-	-	-
92	-	2	1	-	1	1	2	1	1	2	2	1	-	1	2	2	2	2	-	-	-	-	-	2
93	2	2	2	2	1	1	-	-	-	2	2	1	1	1	-	-	2	1	2	-	-	2	-	1
94	2	2	2	2	1	1	-	2	2	1	1	2	2	1	-	-	2	2	-	-	-	-	-	1
95	-	-	-	-	2	2	-	-	-	-	1	2	2	2	-	-	-	2	-	-	-	-	-	2
96	-	-	2	-	2	2	-	2	2	1	1	1	2	2	-	-	1	1	2	-	2	2	-	2
97	-	2	2	-	-	-	2	1	1	2	-	-	-	-	2	1	-	-	-	1	2	-	-	-
98	-	-	2	-	-	-	2	1	2	2	-	-	-	-	1	2	2	-	-	2	1	2	-	-
99	-	-	-	-	-	-	-	-	-	2	2	2	-	1	-	2	2	2	-	2	1	2	-	-
100	-	-	-	-	2	2	-	-	-	2	1	2	2	1	-	-	2	2	1	-	2	1	2	2
101	-	-	-	-	-	-	-	-	-	-	2	-	-	2	-	-	-	1	2	-	2	1	2	-
102	2	1	2	-	-	-	2	2	2	-	-	-	-	-	1	2	2	-	-	2	1	2	-	2
103	-	2	-	-	-	-	-	2	-	-	-	-	-	2	2	1	1	2	2	1	2	1	2	-
104	-	-	-	-	-	-	-	-	-	-	2	-	-	2	-	2	2	1	1	2	1	2	1	-
105	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	-	2	1	2	-
106	1	1	1	1	1	1	2	2	-	2	1	1	2	2	-	-	-	2	-	2	-	-	-	2

FIGURE 7 : 2^{nd} Shimbel matrix (D_2)
(Source: Prepared by Author)

From the Shimbel matrix (D_2) it can be observed that 274 cells have a "0" value which means all the corresponding origins and destinations of these cells are not connected to each other. So, this cannot be the final shimbel matrix and we have to calculate the 3^{rd} order connectivity matrix to replace the additional non-zero values. By repeating the whole process again we perform 5 iterations to get the resultant shimbel matrix (D6) as shwin in below figure.

Iteration 5

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	D6 - Final Connectivity Matrix of Degree Six Where there are no zero cells Which Means all the settlements are connected to eachother at 6th degree																									
2		Ananda	Pendur	Sabbava	Bheemi	Jawahal	Simhadr	K Kota	Chodav	Butchay	Anakapal	Munaga	Rambilli	S Rayav	Kasimk	Madugul	Ravikam	Makavar	Yelaman	S Rayav	Aruku V	Narsipat	Nakkapa	Payakara	Visakhap	Total
3	Anandapuram	2	1	2	1	2	2	2	3	4	3	2	2	3	3	3	4	4	3	4	2	4	4	5	1	66
4	Pendurthi	1	2	1	2	2	2	1	2	3	2	2	2	3	3	2	3	3	3	4	1	2	4	5	1	56
5	Sabbavaram	2	1	2	2	1	2	1	1	2	1	2	2	3	2	2	2	3	3	4	2	4	4	5	1	54
6	Bheemunipatnam	1	2	2	2	2	2	3	3	4	3	2	2	3	3	4	4	4	3	4	4	5	4	5	1	72
7	Jawaharlal Nehru Pharma City	2	2	1	2	2	1	2	2	2	1	1	1	2	2	3	3	3	2	3	4	4	4	5	1	55
8	Simhadri Natinal Thermal Power	2	2	2	2	1	2	3	2	2	1	1	1	2	2	3	3	3	2	3	4	4	4	5	1	57
9	K Kotapadu	2	1	1	3	2	3	2	1	2	2	3	3	4	3	2	2	4	4	5	2	4	5	0	2	62
10	Chodavaram	3	2	1	3	2	2	1	2	1	1	3	2	4	2	1	1	3	3	4	2	2	4	5	2	56
11	Butchayyapeta	4	3	2	5	2	2	2	1	2	1	3	2	4	2	1	2	3	3	4	2	4	4	5	4	67
12	Anakapalli	3	2	1	3	1	1	2	1	1	2	2	1	3	1	2	2	2	2	3	4	4	4	5	2	54
13	Munagapaka	2	2	2	2	1	1	3	3	3	2	2	1	1	1	4	4	2	1	2	4	4	2	4	1	54
14	Rambilli	2	2	2	2	1	1	3	2	2	1	1	2	2	1	3	3	2	2	3	4	4	4	5	1	55
15	S Rayavaram	3	3	3	3	2	2	4	4	4	3	1	2	2	2	5	5	3	2	3	4	4	4	5	2	75
16	Kasimkota	3	3	2	3	2	2	3	2	2	1	1	1	2	2	3	3	1	1	2	4	2	2	4	2	53
17	Madugula	3	2	2	4	3	3	2	1	1	2	4	3	5	3	2	1	3	4	5	1	2	4	5	4	69
18	Ravikamatam	4	3	2	5	3	3	2	1	2	2	4	3	5	3	1	2	2	3	3	2	1	2	4	4	66
19	Makavarapalem	4	3	3	5	3	3	4	3	3	2	2	2	3	1	3	2	2	2	3	2	1	2	4	4	66
20	Yelamanchili1	3	3	3	3	2	2	4	3	3	2	1	2	2	1	4	3	2	2	1	4	2	1	2	2	57
21	S Rayavaram	5	5	4	5	3	3	5	4	4	3	2	3	3	2	4	3	3	1	2	4	2	1	2	4	77
22	Aruku Valley	2	1	2	3	3	3	2	2	2	3	3	3	4	3	1	2	2	3	3	2	1	2	4	2	58
23	Narsipatnam	3	2	3	4	4	4	3	2	3	3	3	3	4	2	2	1	1	2	2	1	2	1	2	4	61
24	Nakkapalli	4	3	4	5	3	3	4	3	4	3	2	3	3	2	3	2	2	1	1	2	1	2	1	4	65
25	Payakaraopeta	5	5	5	5	4	4	5	4	5	4	3	4	4	3	4	3	3	2	2	4	2	1	2	4	87
26	Visakhapatnam	1	1	1	1	1	1	2	2	3	2	1	1	2	2	3	3	3	2	3	2	4	4	5	2	52
27																										

Figure 8: 6^{th} Shimbel matrix (D_6)
Source: Prepared by Author

From the Shimbel matrix (D_6) it can be observed that no cells have a "0" value which means all the origin nodes are connected with the destination nodes. So, the 6^{th} Shimbel Matrix can be considered as the final shimbel matrix D.The Shimbel index of a node is obtained by adding all the row values of the shimbel matric of the corresponding node (Settlement). It determines the smallest number of routes essential for connecting one given node to all the other available nodes in a transport network. The shortest path is included in the Shimbel accessibility matrix, also known as the D Matrix, for each conceivable node pair. The formula for calculating the same is as follows. (A.M Abbas, 2019)

Aij = Sum. Lij

Aij is accessibility index between origin i and Destination j^{th} settlement
Lij is a frictional factor between i^{th} and j^{th} settlement which may vary like: Cost of travel, Distance between 2 nodes, Number of links between zone i and j.

RESULTS AND FINDINGS

REGRESSION ANALYSIS OF POPULATION GROWTH RATE AND SHIMBEL:

The relationship between two variables is determined using regression analysis which indicates the level of dependency and association between two variables. The amount of correlation is determined by the coefficient of determination (R^2) Value. Which is given by

$$R^2 = 1 - \frac{Residual\ Sum\ of\ Squares}{Total\ Sum\ of\ Squares}$$

Here, the Shimbels index of each settlement has been considered as a parameter for transport network accessibility and the population growth rate of each settlement has been considered as a parameter for development. As we are observing the influence of transport accessibility on the development of settlements, Shimbel index is taken as an independent variable and the Population growth rate is considered as a dependent variable in the regression analysis. (Christian Heumann, 2016) (Abu Bakar, 2019)

Table 2: Shimbel index and population growth rate of Visakhapatnam district

S.No	Settlement	Shimbel	Population (2011)	Growth Rate
1	Anakapalli	54	86519	65.78%
2	Anandapuram	66	66577	12.45%
3	Aruku Valley	58	52110	18.29%
6	Butchayyapeta	67	78165	7.46%
7	Chodavaram	56	72006	31.23%
8	Jawaharlal Nehru Pharma City	55	57568	26.67%
11	Madugula	69	55520	16.96%
12	Makavarapalem	66	33757	5.12%
14	Nakkapalli	65	27001	9.98%
15	Narsipatnam	61	114270	44.22%
17	Pendurthi	56	53913	82.73%
18	Rambilli	75	70761	6.11%
19	Ravikamatam	66	6568	6.64%
20	S Rayavaram	77	86519	5.90%
22	Yelamanchili1	57	66577	34.62%

Source: Produced by author

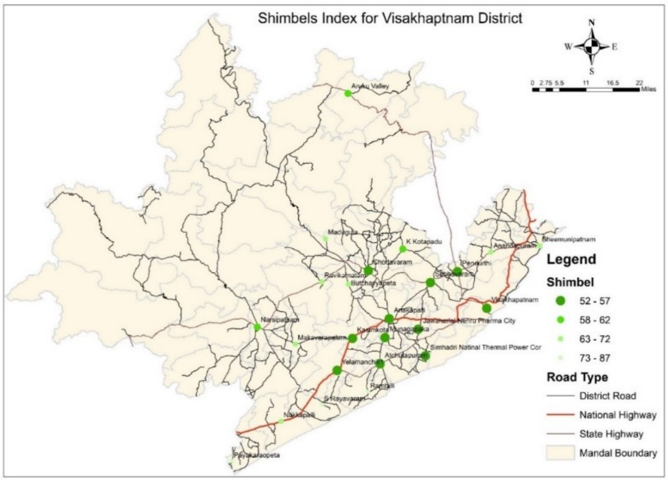

Figure 10: Map showing calculated Shimbel index of Visakhapatnam district
Source: Produced by author

The Settlements with the lowest Shimbel index are considered highly accessible and they seem to have higher population growth rates in the region establishing a positive relationship between accessibility and development. If we talk about correlation then the Shimbel index and Population growth rate have a negative correlation which indicates that accessibility is positively correlated with population growth. The following figure shows the obtained trendline.

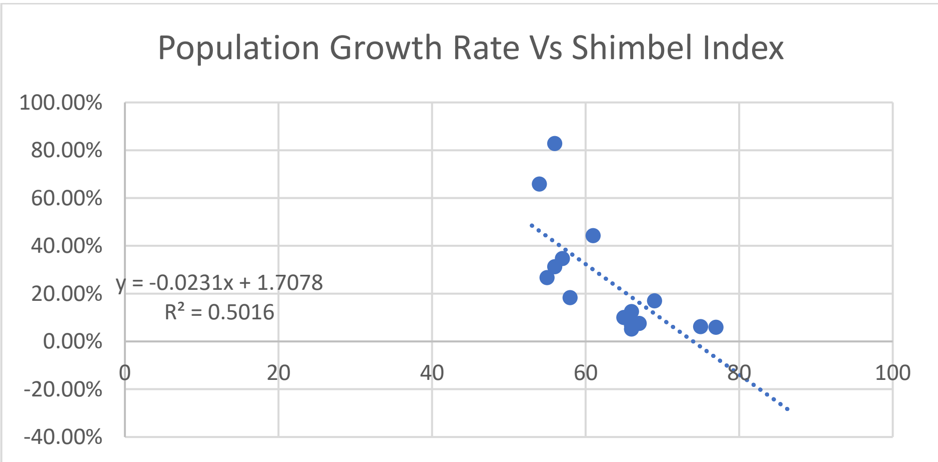

Figure 11: Graph showing Correlation between Population growth and Shimbel Index
Source: Produced by author

$$y = -0.0231x + 1.7078 \text{ and } R^2 \text{ Value} = 0.5016$$

The R^2 score in this model is 50.1 percentage. This means that the regression model explains 50% of the data is fitted. Hence, it can be stated that the plot of the population growth rate and the shimbel index has a reasonably good fit. The coefficient of variable X in the fitted equation has a "Negative" value, this shows that there is an inverse relationship between the variables.

Regression Analysis of Population and Shimbel

Here, the Shimbel index of each settlement has been considered as a parameter for transport network accessibility and also acts an independent variable. The population of settlements has been considered as a parameter for development and acts as a dependent variable as we are observing the influence of transport accessibility on the development of settlements. The results of regression show that with the increase in accessibility there is a subsequent increase in population. The following figure shows the obtained trendline. (Jagrati Jain, 2023)

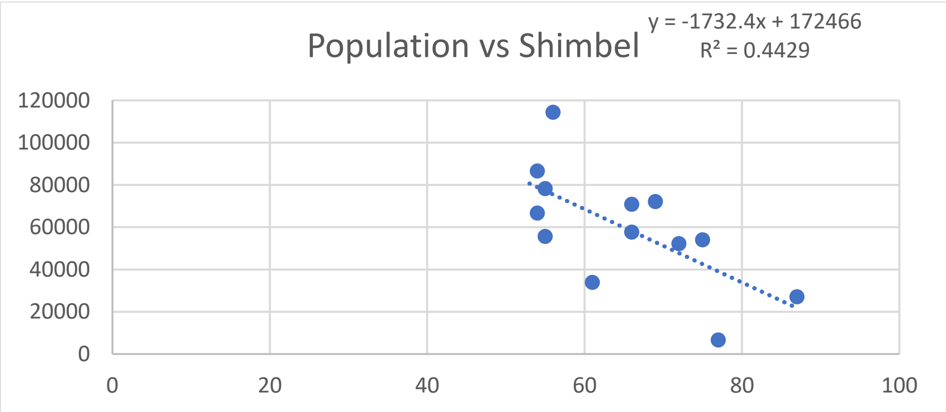

Figure 12: Graph showing Correlation between Population and Shimbel Index.
(Source: Produced by author)

$$y = -1732.4x + 172466 \quad \text{AND} \quad R^2 \text{ Value} = 0.4429,$$

The R^2 value in this model is 44.3 %. This would imply that the regression model explains 44.3 % of the fitted data. There is an inverse relationship between the variables and it can be stated that plot of the population growth rate and Shimbel index does not have a reasonably good fit compared to the previous equation.

CONCLUSION

The regression analysis between two sets of variables shows a negative correlation between both sets of variables (Population growth rate, Shimbel index) and (Population, Shimbel Index) with an R^2 value of 0.5016 and 0.4429 respectively. Inverse proportionality of Shimbel index to the accessibility of the settlement implies that Accessibility and population growth rate are in direct relation. It can be stated that development is in direct relation with the transport accessibility of given settlements in Visakhapatnam regional network. By observing the R^2 values obtained it is evident that population growth rate is reasonable more correlated to accessibility compared to population.

In the research findings, it is understood that the accessibility of a settlement has a significant impact on the development of many sectors like trade, commerce, Industries, tourism, services etc which enhances the development and are directly dependent on the accessibility of a region. The findings can be used to identify the settlements which have lower accessibility measures and improve the same to enhance their development in future. Many researches have proven the positive effect of accessibility on population growth, this has been documented in research like (Duranton and Turner, 2012) and (Beeson, Hirsch and Rewega, 2002). However, many kinds of studies were done at local, urban and regional levels. Depending upon the selection of both the different choices, results may vary and analysis may show mixed results. Some researchers also claim the negative effect of accessibility on population growth, reason being the possibility of out-migration which can be caused by better accessibility. This case was seen in suburban and rural areas. Transport accessibility has a positive effect on population growth and other development parameters and it can have negative impacts as well. (Baum-Snow, 2010).Therefore, scope of the study suggests that the impact of accessibility and connectivity on development can further be investigated involving various other indicators of economic development using the existing results to establish more prominent relations. (Othman, 2021)

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INTEGRATING SPATIAL COST PATH AND MULTI-CRITERIA ANALYSIS FOR FINDING ALTERNATIVE ROUTES DURING FLOODING

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Abstract

Route accessibility is essential infrastructure, facilitating more convenient transit for individuals. Nonetheless, the seasonal monsoon can lead to flooding and impair the accessibility of local transportation, especially in hilly-lowland areas. This study aims to investigate an alternative route access for safe travel from Kota Marudu to Kota Kinabalu, Sabah, during the floods with GIS path analysis and MCDA method. The slope, rainfall, land cover /land use (LULC), distance from the river and river density were utilized to construct the flood susceptibility map using Analytic Hierarchy Process (AHP), while path analysis was applied to find the accessible and safe routes. There are two other routes in the study region, one of which may be utilized as a suitable route. A new route should be considered to create roads in the higher area. The alternate route map suggested in the study is a beneficial tool as caution during the rainy season. As the flood's extent is simply an estimate, it is only possible to forecast the event, and sometimes can result in unexpected tragedy.

Keywords: Cost Path Analysis, GIS-MCDA, Alternative Routes, Flood Vulnerability, Transportation Accessibility

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INTRODUCTION

Floods are situations where water overflows onto ordinarily dry ground. In Malaysia, the main pattern of floods is a seasonal monsoon event. Flooding can occur as a consequence of an overflow of water from a water body, such as a river, lake, or ocean, where the water overtops or breaks levees, allowing some of the water to escape its regular limits, or as a result of rainwater accumulating on a wetland in a flood area. Human environmental alterations or land use changes can cause flooding, including deforestation and the removal of wetlands in the low-lands.

Floodings are not unusual events that can be predicted in a particular area due to many factors and effects facility damages. It includes the accessibility of a particular area's roads that have increased the number of infrastructural danger in recent decades (Suarez et al., 2005). The factors are predicted to influence road infrastructure significantly (Kalantari et al., 2019). Regarding alternative safe routes during flooding, it can facilitate people with more convenient mobility, which also contributes to more vigorous activities, indirectly helping the economic growth of a country. However, the seasonal monsoon and erratic weather may carry the rain that causes water overflow in low-land areas.

Roads submerged in floodwaters will restrict the movement of people. Several examples have been reported in the local news and media over the years, with claims that numerous victims were stranded on the road after being unable to reach their destinations. Some victims were carried away by the flood current as they tried to cross the flood. Thus, with the current IT and software development, it is now easier to analyze data, especially Geographical Information System (GIS) spatial data from many open-source data or related departments.

A GIS is a spatial system capable of creating, managing, analyzing, and mapping various forms of data, especially for natural disasters such as floods (Adnan et al., 2014). By merging location data with other types of descriptive data, GIS connects the data to a map. This process creates the spatial framework for mapping and analysis of flood events in conducting cost path analyses in perspective of today's growing urbanization and the resulting need for better surface transportation options. Traffic-influencing events and demand must be considered while building a road network (Vonderohe et al., 1993). GIS was also used to construct a road information management system, as Thlakma et al. (2015) studied, especially for resolving complicated road network issues.

In order to provide an alternative safe route access, it may be feasible to identify alternative paths that may not be affected by flood by utilizing the GIS technique. Ultimately, a path map showing a safe access route during a flood may be utilized as a detour in Sabah. Two main objectives were set in the study: i. to identify the areas impacted by flooding in the study area, and ii. to examine the proposed or new suitability of route access during flooding in the study area.

GIS PATH ANALYSIS AND AHP TECHNIQUES FOR LOCATING ALTERNATIVE PLANNING ROUTES

Flooding has a terrible impact on people's lives and socioeconomic situations, posing a severe threat to civilization (Qi & Altinakar, 2011). A flood occurs when the channel's capacity fills, and the water flows out of the channel (Huang et al., 2008). The natural cause of flood disasters is due to intense precipitation, prolonged rainfall, snow melt and storm surges. Floods have devastating consequences in underdeveloped countries such as Malaysia. In Sabah, the risk factors that increase flood susceptibility include land use, manufactured structures, and climate change. Land use changes such as dense urbanization and poor dam/drainage construction can trigger flood severity. Floods harm traffic by limiting vehicle movement and disrupting overall road network connectivity, as some impacted roads have become impassable and must be closed. Studying traffic route choice as an alternative for road users is crucial to overcome the spatial network problem.

The definition and concept of "alternative route "route" is a path taken to get from a starting point to a destination. Concerning that, "road" has the common concept defined as a long path extending from one location to another, particularly one having a specifically prepared surface that vehicles may use, which in other words is a long, narrow strip of the road having a smoothed or paved surface used for transport by motor vehicle, carriage, between two or more locations. While "alternative" emphasizes a proposal or scenario that provides a choice between two or more options in which something can be chosen instead. Moreover, it can also be another plan to make something feasible. Thus, an "alternative route" begins at a point where it diverges from the main numbered route and may travel through specific cities and towns and then re-joins the main route some miles later or improve a route for better convenience, as suggested by the Dunn Engineering Associates for U.S.A Department of Transportation (2006).

Mapping flood vulnerability is critical for identifying flood risk zones and developing mitigation strategies (Swain et al., 2020). Prior to selecting an alternative route, it is crucial to identify the affected part of the flood hazard area for alternative route risk assessment. Floods are complex dynamic occurrences; hence the flood vulnerability assessment can be done by using Analytical Hierarchy Process (AHP). AHP is a multi-perspective, multi-objective decision-making paradigm that enables users and planners to extract a quantitative scale of preference from a collection of choices (Ayalew & Yamangishi, 2005). By employing a ranking scale, Saaty (1987) presented a pair-wise comparison matrix (PCM) approach for constructing weighting factors for a particular criterion.

The criteria are then used to create a flood susceptibility map to indicate the severity of a flood in a particular area. The factors can include rainfall distribution, slope, river density, land use, and the distance from the river. The study chose these criteria based on their importance and relevance to flood mapping from various references in previous publications and expert opinions. It will give the rate from the most significant to the minor factor of flood occurrences.

AHP-MCDM is carried out using well-known GIS tools such as ArcGIS and QGIS. It makes completing analytical tasks considerably more straightforward and provides visual aids for problem-solving purposes of environmental matters (Abdul Rasam et al., 2016; Misni et al., 2017; Rasam et al., 2017; Zubir et al., 2022). The collected data may be merged, altered, and displayed to see the projected outcome. As a result, it generates ideas for issue solutions, such as flood mitigation and finding a safe way through the event. GIS and remote sensing (RS) data have mainly been utilized to determine the extent of flooded areas. Flood monitoring in real-time is critical for mitigating floods and limiting their impact (Notti et al., 2017). The combination of flood hazard identification with environmental degradation and climate change characteristics linked with LU/LC variations improved monitoring capabilities (Jalil et al., 2021).

Apart from this, spatial cost path analysis is also conducted. This spatial analysis is the process of modelling problems geographically, computing the findings, and exploring and examining a particular location. The path analysis in GIS allows for the efficient movement of commodities, the efficient coordination and organization of vehicles, and the intelligent analysis of transportation networks. Developing strategic routing strategies may assist in making better judgments and gaining a better understanding of the overall network of spatial scenarios (Jalil et al., 2018; Zain Rashid, 2019; Lokhman et al., 2012; Satti et al., 2022). Optimal route planning is another analysis in GI for traffic route selection based on road network modelling that can help prevent and mitigate traffic congestion during disasters. Genuine road conditions during flooding are recreated using road network modelling to produce a response plan for road users to evacuate depending on the roadways' natural hazards and status.

Network-based problems, such as planning alternate routes, sending emergency vehicles, estimating trip times, and locating facilities, can be managed using a GIS network or path analysis programmes. The programmes can forecast and present to road users with available alternatives using a GIS when specific access routes or links need to be closed due to catastrophic disasters such as floods. It is possible to create an appealing alternative way to display available traffic route options and a transportation network plan by utilizing GIS's ability to display spatial and attributive information as conducted at Jalan P. Ramlee in Penang (Othman & Abdul, 2014). Other research previously also conducted by

Vaishali et al. (2019) showing the capability of GIS for optimum route selection. The study integrated non-spatial (travel time, volume count, location of trip) and spatial data (boundary of city, road network shape file, GPS location of trip, land use shape file) for finding the optimum route path under different conditions. It aims to choose the best route planning for a city involving mitigating traffic problems.

RESEARCH METHODOLOGY

The research procedure consisted of four steps: a preliminary analysis, data gathering, data processing, and a flood vulnerability map. **In the preliminary study**, this research was based on the reference from many papers of previous studies that were conducted as guidance on alternative routes and analysis of the flood-prone, including the topic of the GIS-based Path and AHP method, flood vulnerability factors and risk map. The study area covers Kota Marudu to Kota Kinabalu, Sabah. The existing roads from Kota Marudu to Kota Kinabalu will pass Kota Belud District before reaching Kota Kinabalu, and vice versa. The Kota Belud District is a flood-prone area where the road access is frequently inundated, especially the main road to Kota Kinabalu. Kota Kinabalu is a capital city in Sabah is both an attraction as well as a busy city bursting with people. Thus, the Kota Belud District is an important study area, providing the main roads from Kota Marudu to Kota Kinabalu Road access.

This research's primary type of **data collection** was obtained from open sources. The data included several data classifications: satellite, topography, and hydrological data. Some of the data were selected based on the criteria from previous studies on flood occurrences located in Malaysia, as shown in Table 1. ArcGIS Pro software is the selected platform for manipulating DTM/DEM data and creating a flood extent map. The criteria, including the slope, rainfall, distance from the river, LULC, and river density, were also processed using ArcGIS Pro. Using the produced criteria visualization, the AHP take place to determine the most influencing factor causing floods in the flood extent area (Saaty, 1987). AHP is a multi-criteria decision analysis (MCDA) analytical approach that provides mathematical metrics to mathematically detect the inconsistency of judgments. The primary data processing and analysis chosen for the study is a GIS-AHP and path analysis technique.

Table 1: Data Required in the Study

Types of Data	Data Required	Sources
Satellite	Land Use DEM	Esri STRM satellite (USGS)
Topography map	Road Network River Network	https://extract.bbbike.org/ https://www.hydrosheds.org/
Hydrological Data	Rainfall Data	CRU TS v4.05
Reason	Integrate the data to do a relationship analysis between the data	

The AHP technique was used to determine the significance or usefulness of a set of paired criteria. Each criterion was paired and assigned a score ranging from 1 to 9 based on significance. The criterion closer to 1 suggested that the two criteria were considered equally significant, whilst the criterion closer to 9 indicated that one of the criteria in the pair was much more essential than the other. The preference values for AHP are shown in the study conducted by Saaty (1987). AHP gave the final weighted values valid to create a flood vulnerability map. The flood vulnerability visualizes the progress that could continue to select the alternative route access of the study area. The path analysis was also applied to find the shortest path and generate directions with the routes.

RESULT AND DISCUSSION

The Flood Vulnerability Index (FVI) Map

Five influential flood criteria in the study area include (a) slope; (b) rainfall; (c) LULC; (d) distance from the river; and (e) river density. It was established that these five criteria are crucial to the occurrence of floods, and as a result, their importance was prioritized for predicting flood vulnerability zones. These criteria were used to evaluate which factor influences the most when all are overlaid with the study area's flood-prone area with GIS-AHP method. For example, the slope with the lower value indicates that the land has a lower elevation, thus having more influence on the land inundated by flood.

Figure 1 shows the local flood vulnerability of the study area using MCDM (AHP and PCMs). The area affected by the flood is indicated, with the Pair-wise Comparison Matrix (PCM) and Consistency Ratio (CR) for flood vulnerability. The AHP method was applied to estimate the relative importance value for each criterion of causing flood in the flood-prone area. The weight overlay tool in ArcGIS Pro and the result of AHP were used to create the flood vulnerability map. The resulting layer was then clipped with the flood boundary map as this only focuses on the area in the flood extent. Pair-wise Comparison Matrix (PCMs) was the mathematical operation used for AHP techniques to decide the final weight of each criterion. As for the Consistency Ratio (CR), the inconsistency is acceptable if the value is smaller or equal to 10%. An automatic AHP calculator was utilized to run the calculations to produce the vulnerability map.

The vulnerability map visualizes the place-dependent level of risk resulting from floods within the affected part. The main road access majority falls in the medium and high risk of flood vulnerability zone. Using the route during the rainy season is hazardous for the public. The rating decision of each criterion was based on the data visualization processed in the ArcGIS software. The slope factor was higher within the flood-affected area than the annual precipitation. Lower elevation tends to accumulate water and cause inundation in the area. The slope versus LULC, distance from the river and river density had equal importance of flood factor in the affected area.

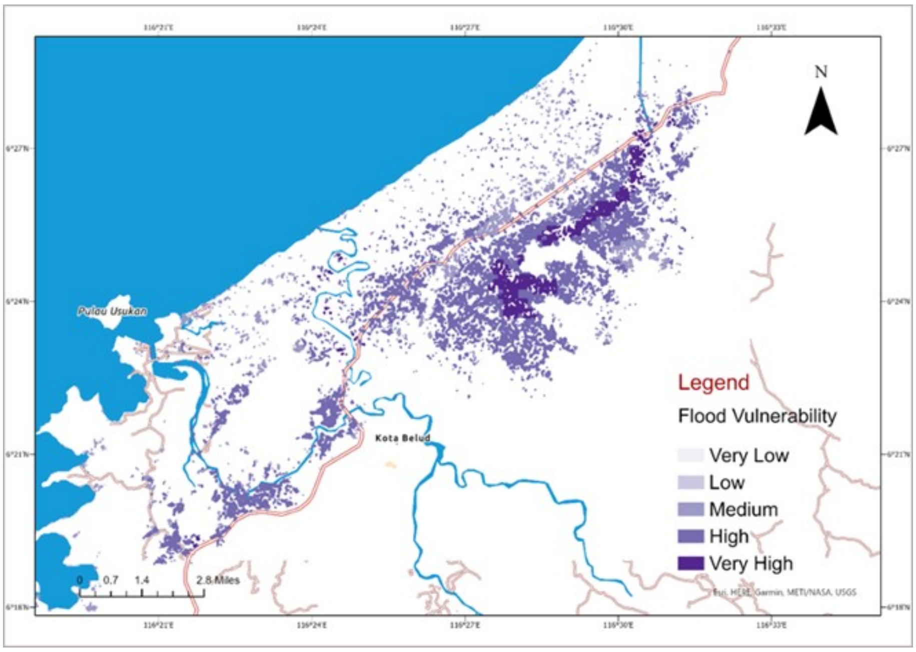

Figure 1: The Affected Areas of the Flood Vulnerability

LULC and distance from the river were more influencing in causing flood in the area than the precipitation. LULC were mostly crops and rangeland that could not penetrate water causing high water runoff. The area was also near the river, bringing water flow from the hills/mountains with a high risk of water overflow. However, the precipitation factor was more important than river density. Although the area is near the river, its density is low. Apart from that, LULC has equal importance with the distance from the river but a higher rating in a pair with river density. Finally, the distance from the river was rated more than the river density.

Table 2 displays the final weights for criteria chosen for flood vulnerability. The flood factor in the hotspot area affected by flood in the scope area ranking 1 was LULC and distance from the river. Both were equally important factors, thus, resulting in the same rank, which was 24.8% resulting weight. The second rank was the slope which was 22.3% weight. The third was the precipitation (15.0%), and the fourthly was the river density, which had the least important factor of flood occurrence in the hotspot area. The percentage value of all the criteria was used to overlay all the criteria layers shown in Figure 2 into one layer to produce the flood vulnerability. The resulting new layer was clipped with the identified flood-affected part polygon layer to analyze its susceptibility level. This process produces the final flood vulnerability, as shown in Figure 2.

Table 2: Final Weights for the Flood Vulnerability Criteria

	Criteria	Priority	Rank	(+)	(-)
1	Slope	22.3%	2	6.0%	6.0%
2	Rainfall/Precipitation	15.0%	3	6.0%	6.0%
3	LULC	24.8%	1	2.7%	2.7%
4	Distance from River	24.8%	1	2.7%	2.7%
5	River Density	13.1%	4	5.2%	5.2%

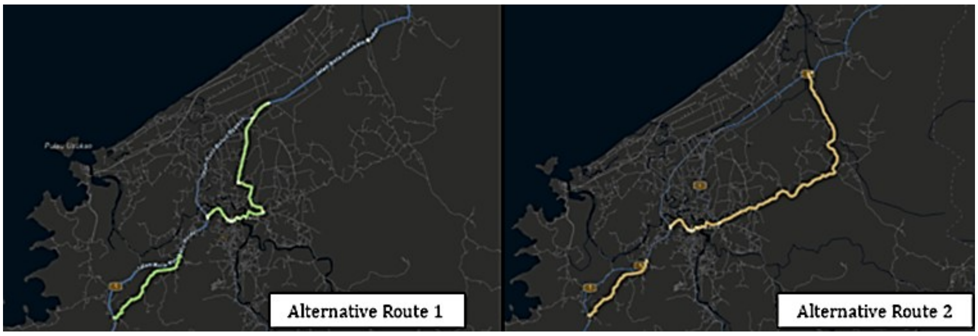

Figure 2. The Optimum Alternative Route 1 and 2 in Kota Marudu and Kota Kinabalu

Alternative Routes Accessibility during the Flooding

The purpose of the route selection only includes one highway facility, and the route will be rerouted away from the inundated region before re-joining the main road again after a short distance. Kota Belud provides several routes from Kota Marudu to Kota Kinabalu. In that way, a few alternative routes could be used for the public to pass between the nodes. The selection of new suitability of route access during the flood was performed. The best route was chosen from some other existing road connections. Apart from the existing roads, a new road proposal was also recommended.

To find the optimum alternative routes, the ArcGIS Pro Network Analysis Tool is used to identify the shortest route, its travel time, and its distance. Figure 2 shows Alternative Route 1 and Route 2 between Kota Marudu and Kota Kinabalu. Other than the primary connection route of Jalan Kota Belud Bypass Kudat/ Kota Marudu that can be used to travel from Kota Marudu to Kota Kinabalu (and vice versa), the connection of Jalan Tuaran-Kota Belud near Jalan Kampung Liwan - Jalan Pekan Kota Belud - Jalan Lama Kota Belud and Jalan Kawang-kawang - Jalan Botong Rosok - Jalan Lama Kota Belud can also be the alternative routes sequentially denoted as Alternative Route 1 and Alternative Route 2. Alternative Route 1 covers a shorter travel time of 49 minutes, while Alternative Route 2 has a longer travel time. It is also the shortest route and closer to the main road than the Jalan Alternative Route 2. Table 3 below shows some information on the criteria listed for the alternative routes.

Table 3: Alternative Routes Criteria in a Normal Situation

	Alternative Route 1	**Alternative Route 2**
Shorter travel time	49 min	1 hr 2 min
Distance	30 mi	32 mi
Closeness to the main road	Yes	No

For selecting the alternative safe route access during the flood, the flood risk map must also be considered in order to select the safe route access during the flood. Figure 3 indicates the alternative road layer overlaid with the final flood vulnerability layer. However, when overlaid with the final flood vulnerability layer, the connectivity of Alternative Route 1 (green) still was affected by the flood. Using the road was unsafe as it falls within the medium and high vulnerability flood area, and most of the road was affected. For example, the Jalan Tuaran - Kota Belud near Jalan Kampung Liwan, is one of the route connections of Alternative Route 1. As mentioned earlier, it was also near the river, which has the most influencing factor in causing floods in Kota Belud.

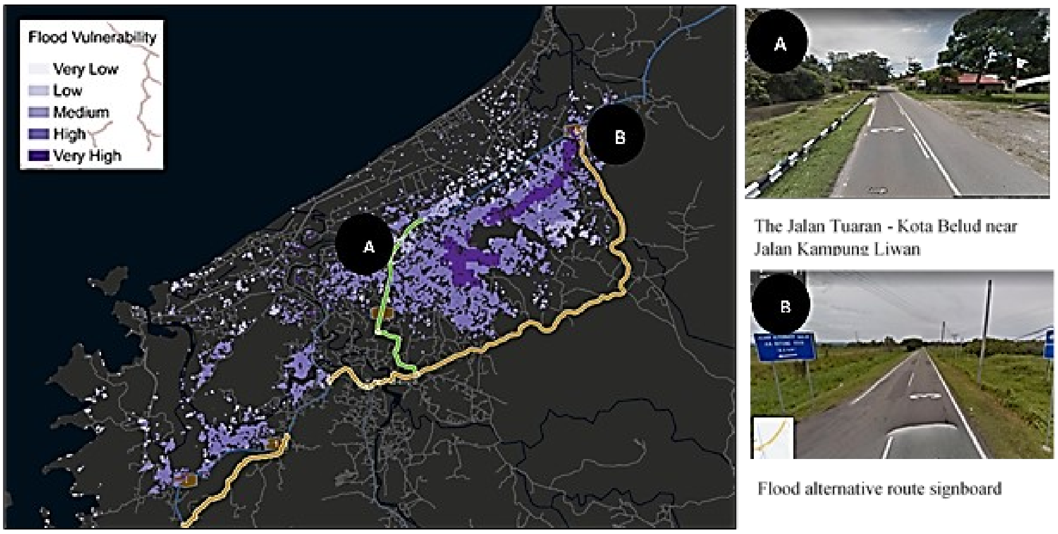

Figure 3: The Alternative Roads Layer during the Flooding

On that note, the Second Alternative Route (Orange) has a longer travel time and distance and is further from the main route, and it is safer to use this path. The flood risk of the path was lower when it connected again to the main road, and the remaining flood-affected part along the path was short and low risk. Alternative Route 2 (Orange) is the final alternative safe route access during the flood from Kota Marudu to Kota Kinabalu, Sabah. Additionally, even if it would be reconstructed for improvement of the road, it will require lower cost because of the shorter flood-affected area and lower risk. Furthermore, this route has been officially demarcated as an alternative path during flooding. The route has a signboard that is stated it as an alternative flood route, as illustrated in Figure 3.

Inclusively, providing infrastructure that is both secure and well-organized is crucial for growth and economic development. Two other roads are available and known to be accessible, but only one avoided being affected by the water that this analysis had forecasted. The second one, on the other hand, was safer to be used, but when it connected to the main road again, it still had a chance of being flooded since the results showed that a tiny portion of the road was still affected, despite being classified as having a low risk of flooding. Flood events can only be predicted and commonly affect low-land areas. There is still a possibility that other areas will also be affected when a very severe flood occurs.

As a result, putting up a proposal for a new road in the more elevated portion of the area would be a better idea. The other aspects that need to be considered in the future study are retrofitting existing infrastructures (Musolino et al., 2022), socioeconomic status, and social services analysis of the local community (Thapa et al., 2022; Loreti et al., 2022; Tsolmongerel & Margreth, 2021) for enhancing risk evacuation and access routes during the flood hazards.

Furthermore, GIS-based management preparations and proposed evacuation routes for flood disasters must be introduced in the state towards a better humanitarian aid distribution process during and after post-disaster (Mohamad et al., 2021; Mohd et al., 2018; Zahari et al., 2020).

CONCLUSION

Floods have threatened the social and economic infrastructure of the flooded region in Kota Belud District, which had a detrimental effect on the area's population development and living level. This exploratory study also affected the mobility of the people travelling from Kota Marudu to Kota Kinabalu through the District. GIS-AHP-Path analysis was used for the flood risk assessment and alternative safe routes during the flood in Kota Belud. The production of the flood vulnerability map using slope, precipitation, LULC, distance from the river, and river density helps identify the areas with high, high, moderate, low, and shallow risk for flooding, respectively. The two routes usually used as alternative routes apart from the main road from Kota Marudu to Kota Kinabalu are the road network connection of Jalan Lama Kota Belud - Jalan Pekan Kota Belud - Jalan Tuaran - Kota Belud and Jalan Lama Kota Belud - Jalan Botong Rosok - Jalan Kawang-kawang. Except for a tiny area impacted by flooding, which could be seen on the final alternative route, Alternative Route 2 was far safer than Alternative Route 1. In comparison, Alternative Route 1 had a shorter travel time and distance and was closer to the main road. However, when flood risk was included in the route selection criteria, Alternative Route 1 was still unsafe because its exposed part was almost along the way. The user may be advised to choose the safer path when the rainy season arrives by using this alternate route map as caution during the season. The current findings were limited by the use of only available data input at a specific time.

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LANDSLIDE SUSCEPTIBILITY INDEX AND NETWORK MAPPING FOR SPOTTING THE AFFECTED AND ALTERNATIVE PLANNING ROUTES

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Abstract

Millions of people were harmed by landslides, and many have lost their lives. Instead of widening the access road during a landslide, an alternative or new road should be introduced accurately. This study was conducted to determine an appropriate GIS-based alternative planning route during landslides in Ranau, Sabah, Malaysia. For determining the criteria weights of the landslide, a GIS-based Multi-Criteria Decision Making (GIS-MCDM) technique was utilised with the extension of the Analytical Hierarchy Process (AHP). The Landslide Susceptibility Index (LSI) map was created using lithology, slope, aspect, rainfall, land use or land cover (LULC), and proximity to a stream. The map was compared with the NASA-landslide historical data for the verification. The study found that lithology, slope, and aspect were the most contributing factors to the local landslide occurrences. The route from Pinausuk to the destination position of Kundasang is the most appropriate choice. An alternative planning route map is a helpful tool for the authorities and it might be also made available to the public, so they will know which path can be taken for more secure alternative access during landslides.

Keywords: Landslide Susceptibility Index (LSI), GIS Network Analysis, Alternative Routes

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INTRODUCTION

Landslides are large-scale movements of soil triggered by earthquakes, volcanic eruptions, falling boulders, shallow debris flows, or slope collapses. They can also be brought on by human activity, especially regarding development. Landslide is mainly caused by physical/built up environment such as slope, road networks, elevation, faults, curvature, land cover, lithology, hydrology and streams (Bacha et al., 2018; Basharat et al., 2016; Kanwal et al., 2015; Khan et al., 2018; Rahim et al., 2018). Forests and slope regions were cleared for development purposes such as logging, road construction, and building construction.

In Malaysia, high-intensity and extended rainstorms are the leading causes of landslides. This scenario is because Malaysia receives much rain—about 3000 mm annually and led to the monsoon system. This system reveals that this nation is prone to landslides, particularly in mountainous and sloping places. However, landslides can occur not only in mountainous areas but also in plane areas. In general, the country is not considered mountainous, but, a specific region has hilly landforms, such as the Tahan Range in Peninsular Malaysia and Crocker Range in East Malaysia. The Tahan Mount rises to 2187 metres, while the Kinabalu Mount is the highest peak at 4095 metres.

Landslides affected millions and caused deaths in particularly vulnerable landslide areas in Sabah. An earthquake phenomenon in Ranau Sabah occurred on 5 June 2015 at 6.0 Richter magnitude scale. This phenomenon led to massive landslides that killed 19 people, and most were caught by landslides (BBC, 2015). Based on BBC News, on 8 June 2015, 30 pupils and staff climbed the Kinabalu Mount for an educational trip, where a teacher and a student were missing. More than 130 people were rescued. Some climbers had made their way down with the help of tour guides and park ranges, as informed by the Straits Times in 2015. On 15 September 2021, the landslide recorded two lives lost and six families affected at Penampang-Tambunan Road. Three lives were lost on 15 September 2021 at Forest Hill construction quarters. The estimated damaged properties after ten days of landslide occurrence are RM174 million, as the Star Times-News reported in 2017.

One contributing factor to landslide occurrences in Kota Kinabalu Sabah is lithology. Lithology types include sandstone and shale, which are highly weathered and have high porosity. The high porosity of the layer has the potential to consist of high-water content (Zikiri et al., 2021). The slope angles class between >35°, slope aspect East and Southwest, lithology and soil types in Kundasang, Sabah are considered landslide-prone areas (Sharir et al., 2017).

Sabah Daily Express in 2013 reported that instead of widening the access route to Ranau, a new road is a better alternative. The new route runs from Telipok to Kampung Randagong in Ranau. Congenially, this new road is the second route which connects Kota Kinabalu and Ranau. This statement has suggested that the construction of new roads is more emphasised than widening the road due to geohazards such as landslides, including in the Kota Kinabalu and Tuaran. The more widening projects carried out, the more frequently landslides occur.

This study identifies a GIS-based alternative secure route planning during the landslides in Ranau. With the technology nowadays in Geographical Information System (GIS) field congenially, there are many efficient methods for obtaining geographical data from open-source internet websites, which leads to high probabilities for proposed alternative routes that are safe from landslide phenomena. GIS users can define the world differently by mapping the position and quantity of things, the density of people and objects, and any phenomenal changes. This geospatial technology used to acquire, manage, interpret, display, and analyse the related data of safe routes during landslide hazards. Previous studies have proven that the virtuous capabilities of the GIS-MCDM method utilised in environmental and natural disaster applications (Abdul Rasam et al., 2016; Mohd Zubir et al., 2022; Mohd Zaini et al., 2021; Mohamad Nor Sing et al., 2022; Rasam et al., 2017; Ridzuan et al., 2017; Saad et al., 2021).

RESEARCH METHODOLOGY

This study was conducted in the district of Ranau of Sabah, Malaysia. Ranau's geomorphology, which is hilly with artificial slopes, is a landslide-prone terrain. The altitude of Ranau is 1176 metres above mean sea level with 1663 mm of annual rainfall and 21.9°C of annual temperature. The estimated area of Ranau is 3609 km^2, with the latest total population being 118,092 in 2020. The study's research methodology was organised into four main sections, including the preliminary studies, data acquisition, data processing stages, and the result and analysis. **The preliminary study** consists of identifying the problem, literature search, selection of study area, and selection of software. The selected technique was AHP, Spatial Analyst, and Network Analyst carried out with ArcGIS 10.8 and Microsoft Excel 2019.

Data acquisition for the study was mainly collected from open-source websites such as OSM, Crudata, USGS, FAO, and ESRI. These datasets covered landslide historical data, satellite imageries such as Landsat 8, and DEM. DEM was used for deriving the slope, aspect and proximity data from the stream. The data were also collected from other spatial data sources: lithology, LULC, rainfall, road, and location. These spatial data were specifically used for identification of landslide-prone areas and the affected route. Landslide historical data were obtained from NASA in point shapefile format. A total of eleven cases of previous landslides were employed for the verification process.

ArcGIS mapping is used for processing landslide historical data in point features of affected route area in Ranau**. The data processing and analysis** stage involved evaluating the landslide criteria for analysing the affected route area as proposed by the literature review using AHP. The main criteria for landslide contribution were lithology, slope, LULC, and proximity to the stream. Image analysis and data management of seven satellite image bands were also processed with the software. For DEM, there are four GeoTIFF images, which were then combined by mosaic to new raster in data management tools in the raster part in ArcToolbox/ spatial analyst tools for slope and aspect mapping. The stream network was created in the hydrology part where the fill was created first, followed by flow direction, and finally, flow accumulation. In flow accumulation symbology, the classes were classified into two classes which are 0 to 30.000 and 30,000 to above, using a raster calculator in map algebra. Next, the stream link was created in raster before converting to a polygon using a stream feature known as stream networks. To process proximity from the stream through the stream network, the multiple ring buffer was applied in the analysis tool with five different distances: less than 300, 600, 900, 1200, and more than 1500.

Identifying the shortest route and the closest facility was also conducted using Network Analyst Extension in ArcGIS. The route in the network analyst toolbar showed four feature layers: stops, routes, point barriers, line barriers, and polygon barriers. The techniques were used to determine the weight of criteria in AHP. The criteria were calculated using M. Excel 2019 and then analysed using LSI in AHP extension in ArcMap. Next, the process applied the weighting of the criteria using AHP. The process of weighting the criteria used is to express the importance of each criterion namely lithology, slope, aspect, LULC, rainfall, and proximity from the stream.

Table 1 indicates the scores based on the literature review on the relative importance between criteria. The matrix calculation was performed to obtain the weights for each criterion used. The value in the normalised matrix was acquired by dividing the score value by the column total. The result of this study is the landslide-prone areas and affected routes in the study area. Next, the analysis was focused on the landslide prone-areas map, landslide susceptibility index map, and a map of alternative safe route planning during a landslide from Pinausuk to Kundasang, Ranau. The closest facility was also discussed in the result and analysis.

Table 1: AHP Calculation

Criteria/ Factors	**Lithology**	**Slope**	**Aspect**	**Rainfall**	**LULC**	**Proximity from Stream**
Lithology	1.000	2.000	2.000	6.000	7.000	4.000
Slope	0.500	1.000	5.000	7.000	5.000	6.000
Aspect	0.500	0.200	1.000	2.000	3.000	2.000
Rainfall	0.167	0.143	0.500	1.000	3.000	2.000
LULC	0.143	0.200	0.333	0.333	1.000	2.000
Proximity from Stream	0.250	0.167	0.500	0.500	0.500	1.000
Total	2.560	3.710	9.333	16.833	19.500	17.000

RESULT AND DISCUSSION

Identifying the Affected Route Area of the Landslides

The areas of the impacted route were examined using the AHP approach to determine the landslide causes. The lithology and slope of the affected route areas were divided into two types: Orthic Acrisols and Orthic Luvisols. Orthic Luvisols is the predominant soil type in the affected route region. The slope was analysed into four ranges which are Class 1 (0-15), Class 2 (15-250, Class 3 (25-35), and Class 4 with more than 35° of contour height. The highest number of lithology or soil types was Orthic Acrisols, while the highest number of slope angles in the study area was 74° (>35). However, in the affected route areas, the lithology is Orthic Acrisols. For slope, the 0-15° were mostly in the affected route area.

The map of the aspect and LULC of the affected route area was analysed into nine flat ranges (-1), North (0-22.5), northeast (22.5-67.5), east (67.5-112.5), southeast (112.5-157.5), south (157.5-202.5), Southwest (202.5-247.5), west (247.5-292.5), and northwest (292.5-337.5) in degree unit. The aspect in the affected route area mainly occurred in the Southwest where the rainfall and wind intended in this aspect. LULC was analysed into nine classes: water bodies, vegetation cover, grass, flooded vegetation, agriculture, scrub or shrub, built area, bare ground, and cloud. LULC in the affected route area mainly was the vegetation cover. However, the affected route is located in the built areas of LULC.

The rainfall map was analysed into six ranges: less than 2880, 2880-2900, 2900-2930, 2930-2960, 2960-2990, and more than 2990 in millimetres per year. The proximity from the stream was analysed into five ranges, namely less than 300, 600, 900, 1200, and more than 1500 metres. The rainfall in the affected route areas mainly occurred at 2900 to 2930 mm/year, which was a moderate pattern. The proximity to the stream was more than 1500 metres, meaning the roads were far from the stream.

Based on the criterion's map in the affected route area, the lithology was a criterion that affected all areas in the route area prone to landslides. The landslide phenomena can occur at any time in the affected route areas where several places are involved, namely Kundasang, Pinausuk, Mohimboyon, Semuruh, Kauluan, Dumpiring, Noluoh, Koporingan, and Tambiau. The following analysis on the slope affected several areas, such as Mesilau, Liposu and Tamalang. The aspect also affected the areas such as Kundasang, Mesilau, and Ruhukon. The rainfall affected forest areas at Ranau near the Trus Madi Forest Reserve and the Sinua Village. LULC and proximity from the stream are the criteria less affecting the area to the occurrence of landslides.

Based on AHP-MCDM result with considerations to the selected criteria, the finalised pairwise matrix was prepared as shown in Table 2. The normalised matrix was based on the weighted criterion score value—the normalised matrix results from dividing the score value and column total.

Table 2. Finalised Pairwise Matrix

Normalise Matrix								
	Litho-logy	**Slope**	**Aspect**	**Rainfall**	**LULC**	**Proximity from Stream**	**Row Total**	**Weight**
Lithology	0.391	0.539	0.214	0.356	0.359	0.235	2.095	0.349
Slope	0.195	0.270	0.536	0.416	0.256	0.353	2.026	0.338
Aspect	0.195	0.054	0.107	0.119	0.154	0.118	0.747	0.124
Rainfall	0.065	0.039	0.054	0.059	0.154	0.118	0.488	0.081
LULC	0.056	0.054	0.036	0.020	0.051	0.118	0.334	0.056
Proximity from Stream	0.098	0.045	0.054	0.030	0.026	0.059	0.310	0.052
	1.000	1.000	1.000	1.000	1.000	1.000	6.000	1.000

The finalised pairwise matrix generating the criterion priorities is shown in Table 3. The criterion priorities in affected route areas as the most contributing landslide occurrences were lithology (34.9%), secondly was slope (33.8%), thirdly was aspect (12.4%), then was rainfall (8.1%) and LULC (5.6%), and the lowest contributing factor of the landslide occurrences was proximity from the stream (5.2%). Therefore, based on this finalised pairwise matrix calculation result, the consistency ratio is 0.078 or 7.8%, accepted as the consistency ratio is not more than 0.1 or 10% (Saaty, 1987). The consistency ratio was obtained from Eigenvalue and random index (RI).

Table 3: Criterion priorities

No.	Criteria	Priority	Rank
1.	Lithology	0.349 or 34.9%	1
2.	Slope	0.338 or 33.8%	2
3.	Aspect	0.124 or 12.4%	3
4.	Rainfall	0.081 or 8.1%	4
5.	LULC	0.056 or 5.6%	5
6.	Proximity from Stream	0.052 or 5.2%	6

The final result of the AHP technique was a LSI map, in which the index value varied from 149.8 to 216.2 for low-susceptibility areas and very high-susceptibility areas, respectively (Figure 1). However, for straightforward interpretation and visual of the areas, the result of the LSI map was classified into four classes which were low, moderate, high, and very high. The low susceptible areas were Kundasang and Pinausuk, Himbaan, and Purak Pogis. The highly susceptible areas were the Mesilau, Kundasang, Kiwawoi, and Ranau. These susceptible areas of the landslide occurrences were due to the criteria: lithology, slope, aspect, rainfall, LULC, and proximity from the stream, potentially influencing the landslide phenomena.

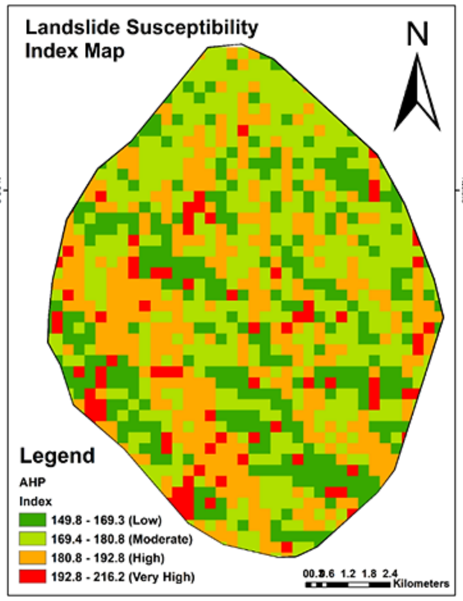
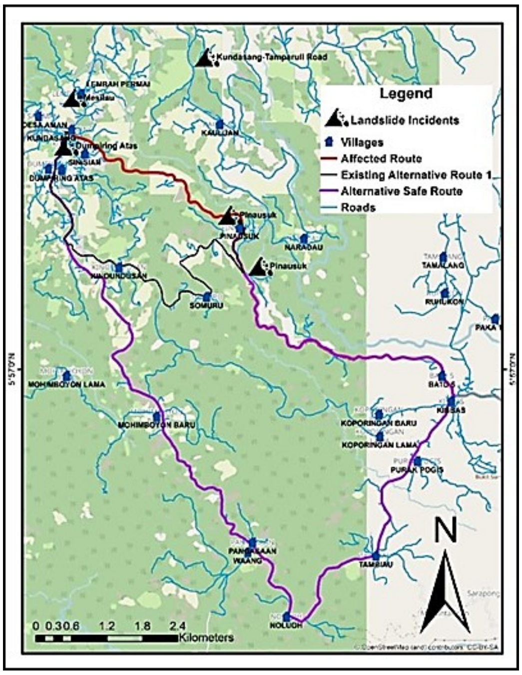


Figure 1: Landslide Susceptibility Index Map (LSI) of the Affected Route Areas

Alternative Routes during Landslides

Figure 2 indicates the map of alternative safe routes during landslides in Ranau, mainly from Pinausuk to Kundasang. The existing Alternative Route 2 was selected as the safer alternative route since this road was safer than the existing Alternative Route 1, as shown in the image of the existing Alternative Route 1 and the comparison of both alternative routes in Table 4. Compared to the alternative route, the existing Alternative Route 1 during landslides in Ranau is from the Tamparuli-Ranau route to the Semuruh-Kinoundusan road and to the Kibbas- Mohimboyon road for going to the destination location (Kundasang). The existing Alternative Route 1 is used regularly by drivers during landslides for access due to the short distance.

However, this road is an unpaved and small road where cars have difficulty passing. In short, this road may be pretty risky and unsafe. The existing Alternative Route 2 was safer because the road was paved and could be accessed by two cars, as shown in Table 4. Table 4 indicates the comparison of existing Alternative Route 1 and existing Alternative Route 2 in terms of an average driving distance, time, and road conditions.



Existing Alternative Route 1 used regularly by drivers-Semuruh-Kinoundusan Road

Existing Alternative Route 2 is rarely used by drivers- Kibbas-Mohimboyon Road.

Figure 2: Alternative Route from Pinausuk to Kundasang, Ranau during Landslides

Table 4: Comparative Existing Alternative Route 1 and Existing Alternative Route 2

Comparison	**Existing Alternative Route 1**	**Existing Alternative Route 2**
Driving Distance	7.9 km	22 km
Driving Time	30 minutes	44 minutes
Paved Road	No	Yes
Safer	No	Yes

Verification of the Alternative Safe Routes during Landslides

The verification map of the landslide susceptibility index and an alternate safe path was also conducted for the result practicality as the actual situation. Verification is necessary to determine whether the map's outcome is appropriate for usage. The verification data used was the landslide historical data acquired from NASA where 8 locations and 11 cases were reported. The data overlapped with the LSI and alternative safe route maps during landslides from Pinausuk to Kundasang, Ranau. Based on the LSI map, the location along the affected route was low susceptibility to landslides. However, the route near the Pinausuk village was identified as highly susceptible to landslides. The existing Alternative Route 1 from Pinausuk through Semuruh-Kinoundusan was identified as having low and moderate landslide susceptibility.

Most of the identification of new alternative routes is high susceptibility to landslides. In contrast, the existing Alternative Route 2 from Pinausuk through Kibbas-Mohimboyon was found to have an as high susceptibility to landslides. However, there is no landslide occurrence along this alternative safe route.

Regarding the proposal of new alternative safe route accesses during landslides, another safe alternative road is better to facilitate drivers moving to their destination, especially from the Pinausuk village to Kundasang, where roads in the Pinausuk village area were often affected due to landslide occurrences. The new alternative roads must be built in areas identified as low susceptibility landslide areas, or at least in areas with medium susceptibility landslides and have a suitable soil structure and soil type (lithology), as well as take into consideration of the slope and aspect. In addition, the many alternative routes would help reduce traffic congestion in the area as well as help reduce the land surface load in the area because drivers will use more than one road to their destination. The local agencies can assist in estimating the cost of proposed route development and maintenance.

This study also suggests that the result of the susceptibility index can be enhanced by integrating the holistic setting risk criteria (Sim et al., 2022), such as social vulnerability, climate change, and other disaster risk factors, for providing a significant cost estimation of the route development and maintenance (Nor Diana et al., 2021). Furthermore, a geospatial real-time monitoring system (Mohd Mokhtar et al., 2021; Shankar et al., 2018) can be further explored for better route planning during natural disasters (Mohd Zahari et al., 2020) in the district.

CONCLUSION

Landslides have killed and injured millions of people, with Sabah in Malaysia being particularly at risk. The present state government stated that building a new road rather than expanding an existing one is the best option for the access route to Ranau. Consequently, GIS technology was implemented in this study to gather geographic data from open sources, which increases the likelihood of the recommended alternate safe path from the landslide danger in the district. The affected route area analysed using the GIS-AHP technique based on the six selected parameters showed that the landslides' most contributing factors were lithology, slope, aspect, rainfall, LULC, and proximity from the stream. The LSI map included four classes of landslide susceptibility index, namely low, moderate, high, and extremely high; the landslide prone-areas map indicated that eleven landslide incidents were also recognised. These maps are beneficial to identify the risk susceptibility of landslides, as the Mesilau, Kundasang, Kiwawoi, and Ranau were recognised as very highly susceptible areas. The main findings of the network analysis have suggested that the safest route and the closest facility is the route from the Pinausuk village (source location) to

Kundasang (destination location) through the Tamparuli-Ranau route and Kibbas-Mohimbayan, Kundasang route, with the length of 22 kilometres and 44 minutes of driving time. The public should be aware of the alternative safe route map to know which path may be utilised for safer option access during landslides. The result of the study was constrained by the use of available data input and occurs only at a specific time.

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TRANSMISSION SUITABILITY ROUTE MAP USING THE LEAST COST PATH ANALYSIS (LCPA)

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Abstract

This study uses a Least Cost Path Analysis (LCPA) to create a transmission suitability route map. Environmental issues including electromagnetic pollution, habitat fragmentation, forest clearing, and the sight of pylons and power lines, and electromagnetic pollution are just a few that may come up during the planning and construction phases. The study's objectives are to define the criteria for a suitable transmission route, map the current transmission from Kidurong to Kemena in Bintulu, Sarawak, and suggest a new, LCPA-based transmission route that meets these criteria. It is necessary to determine the criteria that influence the construction of the route. There are three main categories for the proposed routes. There are technical, human health, and natural environments. The road layer and slope layer are combined for the technical group. The residential layer is part of the human health group, and land use is associated with the natural environment. During the planning of a potential power line route, weight was assigned to the criterion maps. The outcome demonstrates that the suggested route was built based on most flat sections, with only a little portion passing through the sharpest sector because there is no other way to depart from the path to avoid it. The output route is nearly straight from the source location to the destination point. The route also curves in a couple of places to go around the step area. The proposed transmission line is inside the buffer zone, and there are no other routes in the area that are more than 1 km from the road. Class 1 has a low dwelling density; therefore, the route passes through it for the residential evaluation. Additionally, there are a few places where the route passes through class 2 because only class 2 has a lower housing density.

Keywords: Least Cost Path Analysis, Remote Sensing, Transmission Line, Weight Overlay, Multi-Criteria Analysis, Model Builder

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INTRODUCTION

Due to increased energy demand and the addition of new communities to the electrical network, transmission lines need to be regulated and designed in a way that minimizes potential effects on the population's health, maintains landscapes, and removes animal disturbances (Abd Latif Z, et al.,2022). Sarawak Energy Berhad (SEB), an energy development organization that transports and distributes electricity largely in Sarawak, is a vertically integrated power utility. Power transmission businesses have emerged as a result of the electric power sectors' exponential expansion in power demand (Atkinson DM, et al., 2005). Numerous aspects that have an impact on the route should all be taken into consideration while choosing an appropriate route. Due to things like pylon visibility, the clearing of forests, the fragmentation of habitats, electromagnetic pollution, and other factors. Power lines can significantly harm the environment during the planning and construction phases (Bailey K et al.,2005). More investigation is required in this area before starting any activity involving the transmission line's route.

This study aims to produce a transmission suitability route map using the Least Cost Path Analysis (LCPA) based on Geographical Information System (GIS) approach. This study has three objectives that must be accomplished. Finding the criteria for suitable transmission routes is the first objective of this study. The second objective is to map the current transmission going from Kidurong in Bintulu, Sarawak, to Kemena. The final objective is to suggest a new transmission path that would be suitable for using LCPA. GIS can be used to determine the optimal route for a transmission line and find an appropriate evaluation model. The best nodes of the energy tower must first be located. The Least Cost Path will then be used to find the "cheapest" route connecting two sites within a cost surface. Least-cost path analysis uses raster data. Find the path connecting cells with the lowest overall cost by using a cost raster that shows the cost of traversing cells. By creating an accumulated cost surface on which a line connecting the starting point and the destination can be determined, LCPA can be carried out. The accumulated cost surface is created from the cost surface by calculating the cumulative cost of each cell starting at the starting point (Bagli, Geneletti, & Orsi, 2011). This stated that designers should constantly consider alternate potential terminal locations while determining the ideal routing. It has also been shown that employing different weight scenarios can help in adapting the model to different social and environmental situations. A real-world case study in Bintulu Sarawak is reviewed to test this approach.

LITERATURE REVIEW

GIS in Management of Electricity

Over the past few decades, electricity firms have constructed power transmission networks to keep up with the rapidly increasing demand for electricity;

nevertheless, the availability of suitable locations for new transmission lines has been constrained by rural development and growing environmental concerns. Various types of analyses can be carried out, including optimal area selection, route choice, profile evaluation, engineering tower and wire design, and cost estimation utilizing GIS. Additional information, such as location, voltage, and information on electrical distribution, can be provided using GIS. The possibilities of GIS for managing electricity in a building have been practically proved in earlier studies (Saad N, 2021; Pullinger & Johnson 2010). This spatial technique has also been combined with MCDM/MCE to determine whether a certain application is appropriate (Ahmadi, S. et al., 2008; Mohd Zaini J C et al.,2021).

Details on a computer system that connects a database to a map can be more efficiently organized using GIS. A GIS may also enable the updating and reliability of the information. GIS should be able to support the requirements of large-scale energy infrastructure. Information detailing each customer's characteristics, such as location and electricity use, can be managed by GIS effectively (Burrough P.A & McDonnell R.A.,1998). GIS can also be utilized in the investigation, analysis, and design of electrical distribution systems in the field of electrical power. GIS technologies are also being developed to assist in the design of a new residential development's electrical supply network (Majid MR, et al., 2018). Furthermore, GIS can provide high-quality attendance for the automation process for electricity customers. In addition, the GIS application can recreate the design of electrical utility work methods.

Least Cost Path Analysis

Least-Cost Path Analysis is based on a raster and has a narrower focus. It discovers the path between cells with the lowest aggregated cost by using a cost raster that defines the cost of traveling through each cell (Hashim H, 2021). A source raster, a cost raster, cost distance measures, and an algorithm for determining the least accumulative cost path are all required for a least-cost path analysis. Examination of the LCPA is useful for route planning. It has been used to determine the best paths for power lines, for example (Bagli, S., Geneletti, D., & Orsi, F.,2011). In order to determine the best route for a power line, multi-criteria evaluation, and LCPA are coupled. Firstly, cost surfaces and alternative paths were identified using spatial multi-criteria. MCE was then utilized to compare and rank the alternatives based on their overall appropriateness. Lastly, A sensitivity analysis allows for the assessment of the resulting stability and the identification of the most essential aspects in the evaluation.

Least-cost path analysis is particularly appealing for power line routing since it is a quick and repeatable technique that allows the user to combine data from several sources. In the comparison phase, different evaluation viewpoints are employed to adapt the procedure to diverse circumstances. For example, if there is environmental regulation, an economic approach would most likely provide a good response, with the entire cost being the most important factor to consider. A common application of least-cost path analysis in wildlife management is corridor or connectivity studies (Rasam A R.A.,2013). In this research, the origin cells reflect places of high habitat concentration, and the cost raster is the weighted sum of cost elements such as slope, land cover, altitude, water, and human activity (e.g., population density and roads). The study's findings will identify the least expensive wildlife movement routes. LCPA can be accomplished by constructing an accumulated cost surface on which a line can be drawn from the origin to the destination sources (Douglas D.H.,1994).

The accumulated cost surface is formed from the cost surface by calculating the cumulative cost of each cell from the beginning point. An algorithm searches among the nearby cells of the beginning location for the cell with the lowest value. After selecting these cells, the algorithm iterates its procedure: the selected one is now the starting point, and its nearby cells are searched to locate the one with the lowest value. The least-cost path between any destination point and the pre-defined beginning point is eventually discovered by traveling backward from the destination point through the accumulated cost surface, picking cells with decreasing values (Lee J, Stucky D.,1998). Low-cost route mapping has also been used in recent years in archaeology to analyze past social and economic relationships (Yu C, Lee J, Munro Stasiuk M.J.,2003) as well as in usability research such as accessibility to medical services.

METHODOLOGY

The designation of the study region is the first step in this investigation (Figure 1). Then comes the data acquisition phase, in which the study's data is acquired (Figure 2), and after the acquisition process is completed, the data processing processes are taken over. The data processing is analyzed using LCPA. Finally, the analysis and output of the final findings of the study will be generated.

Figure 1: Study Area: Bintulu Sarawak
Map Source: OpenStreetMap

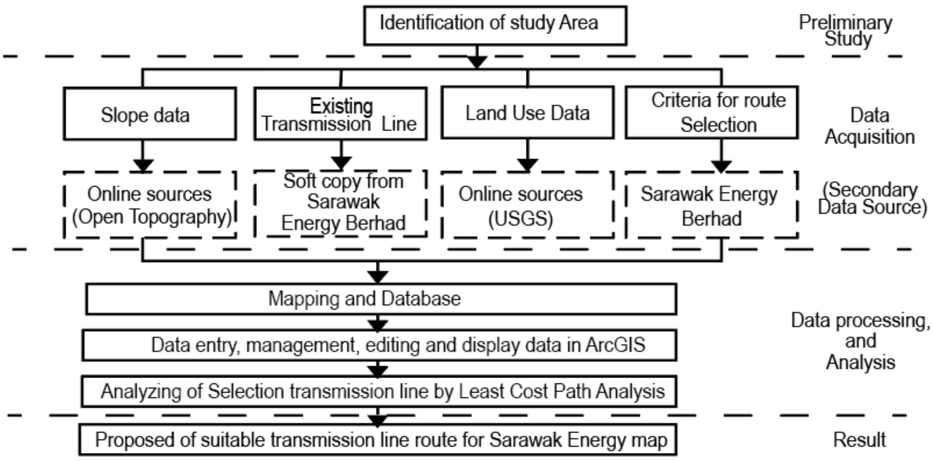

Figure 2: Methodology Flowchart
Source: Author's Flowchart

Data Acquisition

Figure 2 shows that road and residential data is in shapefile (.shp) format, which can be opened immediately using ArcGIS software. Aside from the digital topographic map, the location of the existing transmission line was determined using data provided by Sarawak Energy Berhad (SEB). The coordinates of the origin and destination sources will then be imported into ArcMap. The data soil contains information about the type of soil. The data comprises a complete set of attribute codes as well as topological structuring. The attribute codes are used to characterize the feature-represented area's characteristics. The data can be accessed in GeoTIFF format from USGS online sources.

Data Processing

Generation of the Land Use Map

Two types of software have been used to create land use maps. The data is processed using ERDAS software, then ArcGIS is utilized to convert the raster image to features for spatial analysis. ERDAS software is used to process the data, and ArcGIS is utilized to convert the raster image to features for spatial analysis. Removing Haze - The data is obtained straight from the USGS. The first step in image processing is radiometric enhancement. Radiometric enhancement is the process of removing haze from an image. A cloud in the image can affect the accuracy of the results.

Geometric Correction - Image registration and image-to-map registration are the two methods of geometric rectification. In the viewer, collect ground control points (GCPs) for the source image. The transformation to resample or calibrate the image is computed using corresponding reference points. Subset - Image files frequently contain areas that are substantially larger than the research area. It is used in these circumstances to minimize the size of an image file so that only the area of interest is included (AOI). This not only removes unnecessary data from the file but also speeds up processing because there is fewer data to process. To acquire the desired area, a subset is created. A subset is made to obtain the desired area.

Image Classification - Classification is the process of categorizing pixels based on their data file values into a finite number of separate classes or categories of data. If a pixel meets a set of criteria, it is allocated to the class that corresponds to those criteria. The computer system must be trained to recognize a pattern in the data as the first step in the classification process. Training is the process of developing the criteria for recognizing these patterns. Training produces a set of signatures that serve as the criterion for a set of proposed classes. There are two methods for categorizing pixels into distinct groups. There are two types of classification: supervised classification and unsupervised classification. Unsupervised image classification was utilized in this study to build a land use map of the study area.

Recode - Figure 3 depicts the outcomes of applying to recode to the image. The goal of Recode is to limit categorization to a few classes. Recode can be used to condense all of the learner sections into a few classes. This project has only 5 classes, according to the results. There are forests, bodies of water, cities, farms, and bare earth. Accuracy Assessment - Accuracy evaluation was the process of determining how close outcomes were to values acknowledged as true. The Erdas Imagine software can detect discrepancies in images. If the findings are greater than 80%, the data is considered accurate. The accuracy testing yielded an overall accuracy of 94.00% with a kappa coefficient of 0.9067, which was regarded as adequate by modern picture categorization standards.

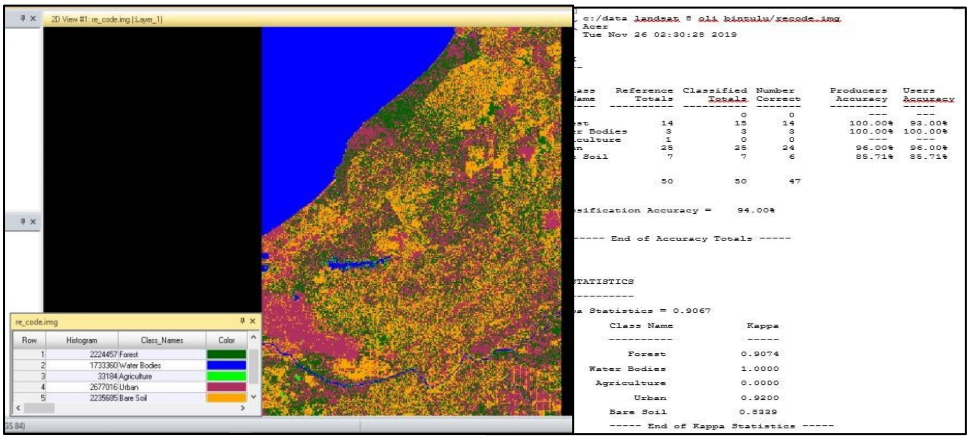

Figure 3: Result of image recode and classification.
Source: Results of the Author's analysis

Designing Potential LCPA Routes

Model Builder Development

Model Builder is designed to assist in the selection or design process of determining the optimal path for transmission line sitting. A new toolbox is constructed in this study using a few model builders. Figure 4 depicts the model builder that is used to solve the choice problem. Each operation in the model builder is represented by a rectangle, and each dataset by an eclipse. The blue ellipse represents the input dataset, while the green eclipse represents the processed result. he inaccuracy is easily detectable, the process will be repeated for the duration of the project.

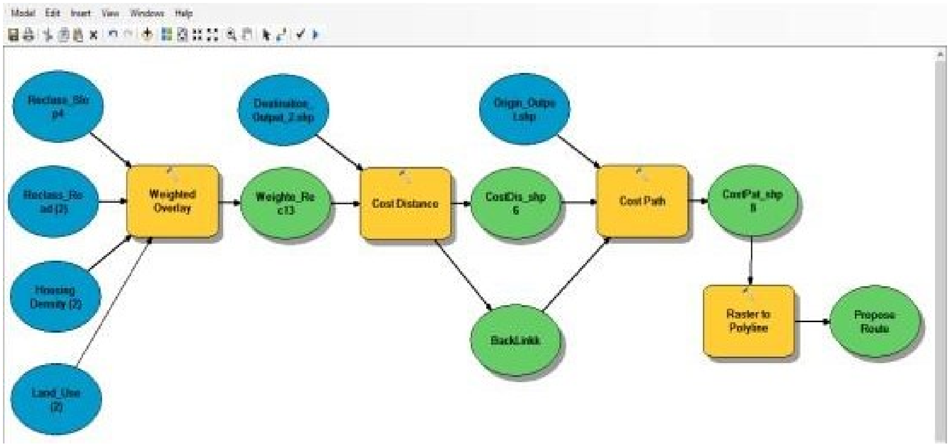

Figure 4: Model Builder for the best Transmission line route
Source: Author's Flowchart

Weight Overlay Analysis

The LCPA technique is based on the definition of a cost surface, which is a raster map with values reflecting the "cost" of passing over each cell. The cost surface can be computed by taking into account all of the parameters that influence the routing process of the linear infrastructure and integrating them using a multi-criteria evaluation. The re-classified slope layer will be integrated and weighted with another dataset in this project to construct a dataset to estimate the cost of creating a path.

Cost Distances Analysis

The cost distance (or cost-weighted distance) function operates an output raster with the source and the accumulated cost surface, assigning a value to each wax cell that is the least accumulative transmission line cost from each cell back to the source. The value influences the cost, the lower the value, the lower the cost. Each cell in the cost-weighted raster has the least amount of influence on the total. The cost-weighted distance function generates two costs: a cost-weighted distance raster and a cost-weighted raster direction. The cost range raster displays the lowest cumulative cost to the nearest origin for each node, but it does not specify how to get there. The direction raster provides a road map to identify the quickest and cheapest route back to any cell. Calculating the raster direction for each cell to determine the code identical to the neighboring cell is the best way back to the nearest integer numbered 0 to 9. The value 0 is used to represent the source's location. The numbers 1 through 9 represent the direction, clockwise from the right.

Cost Path Analysis
The following step is to construct a Cost Path that is continuous from cost distances. The cost path makes use of two rasters generated by a cost distances tool: the least cost distances and the backlink raster. The cost distances or path distance tools are used to generate these rasters. The backlink raster is used to retrace the cheapest path from the destination to the sources over the cost distances surface.

RESULT AND ANALYSIS
The next step is to design a Cost Path that is continuous from cost distances. The cost path employs two rasters created from a cost distances tool: the least cost distances and the backlink raster. These rasters are generated using the cost distances or path distance tools. The backlink raster is used to retrace the least expensive route from the destination to the sources over the cost distances surface.

Criteria for Route Selection
The electrical transmission line route should be designed with the optimum time, cost, and labor in mind. The ideal cost may be examined under two primary headings: expropriation and construction costs. The slope, land usage, and residential and road information all influence the route's construction cost. Land usage determines whether expropriation costs are high or low by influencing real estate value. According to SEB technical regulations, the following criteria must be met for the route to be determined:

a) The elevations throughout the route are kept to a minimum by passing as close to roadways as feasible.
b) The high transmission line path should run near highways to ease traffic and reduce maintenance costs for electric transmission lines.
c) The density of dwellings along the route should be kept as low as feasible.
d) Land use is critical in determining the location of the utility pole. The path should not go through valuable terrain, which raises the cost of expropriation, or through troop locations.

By combining multiple conditions, the "cheapest" approach to connecting two places within a cost surface can be calculated. Transmission lines carry a high voltage of electricity over a long distance from the power plant to towns. The SEB's main concern in planning a new route for transmission lines is the state of human health. As a result, the planning stage of nodes planted in communities must prevent other issues such as being close to dwelling areas. SEB also wants to avoid visible exposure of the transmission line to residential areas since it can transmit waves and disrupt television signals, among other things.

For technical reasons, the heights throughout the route are as close to roadways as possible. The steepest surface is unsuitable for building. This is because the construction at the steepest surface may be costly. As a result, a value greater than 300 is not acceptable for construction Another technical feature is identified by the road layer. Routes that are more than one kilometer from the road are not acceptable zones for the transmission line. This is since the longer the travel, the higher the cost. A location near the road is chosen to reduce maintenance costs. The impact of transmission line routing on the natural environment is also considered. The usage of land is critical in determining the location of the utility pole. Line siting near wetlands and water bodies is avoided since it may have an impact on the habitat and wetland species, such as the electrocution of birds and sediment deposition in water bodies during construction, among other reasons.

The Existing Transmission Line

The existing transmission line in the study region spans 17.4375 kilometers between two substations (Figure 5). PMU Kidurong, located in Tanjung Kidurong, is the generation origin, while PMU Kemena, located in Kg Kemena, is the generation destination. The following are the coordinate origin and destination sources: (Table 2):

Table 2: Coordinate the sources and destination Point

Name	X (meter)	Y (meter)
Sources Point (PMU Kidurong)	73 2561.71	36 3563.66
Destination Point (PMU Kemena)	73 5137.49	34 8464.96

Source: Author's Calculation

.

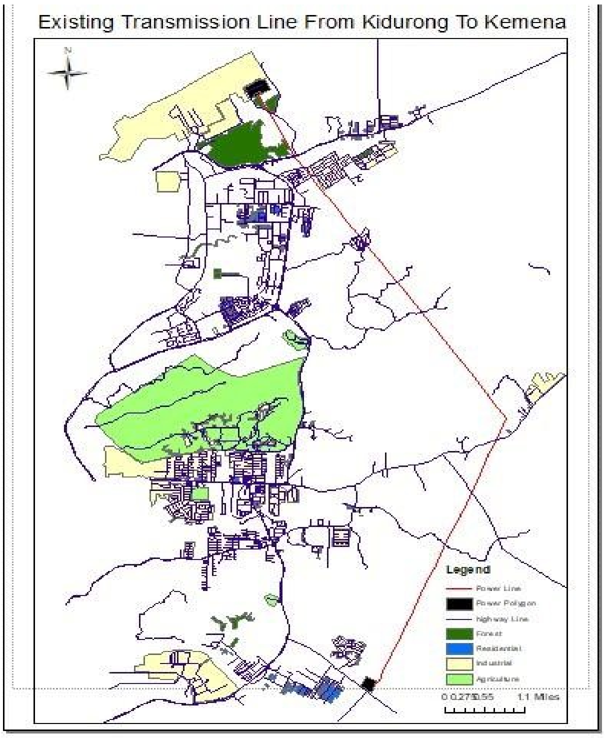

Figure 5: The current transmission line and its sources.
Source: Results of the Author's analysis

Results of the Weighted Overlay Analysis

After overlaying all the layers and assigning their final weight based on the prior literature assessment, several outcomes are produced. According to the prior literature analysis of the expertise in this subject, the opinion regarding the rating of suitability for each layer in this project varies.

Proposed Route

The route is determined by relying on the findings of the literature review. The majority of them divide the layer into three key categories: technical, human health, and natural environment (Table 3). The slope layer and road layer are organized for the technical group. The residential layer is part of the human health group, and land usage is part of the natural environment group. During the planning of a potential power line route, the criteria maps were given weight.

Table 3: Weight was assigned to the criteria maps.

Criteria	Weight for Criteria	Sub Criteria
Technical	26	4.3.1
		4.3.2
Human Health	62	4.3.3
Natural Environment	12	4.3.4

Source: Author's Calculation

Evaluation Of the Route

The output of an existing transmission line and the output of a new transmission line are assessed. The evaluation is necessary to investigate the factors that influence transmission line routing.

Evaluation of Slope Layer

Figure 6 depicts the slope layer route transmission line. Only a few parts of the route travel through the steepest area because there is no other route that can be deviated from the path to avoid it. From the source location to the destination point, the output route is nearly straight. Of course, it is not a completely straight line; there are a few sections where the route curves to avoid the step area.

Evaluation of Road Layer

Figure 7 depicts the transmission line routing in the road layer. The existing transmission line and the proposed transmission route are both inside the buffer zone; no route is more than 1 km from the road. The red line depicts the existing transmission route, whereas the blue line represents the transmission route developed using LCP. The existing transmission route is 17.4375 kilometers long, while the Least Cost Path route is 17.1425 kilometers long. The length difference between the two routes is 0.295 km.

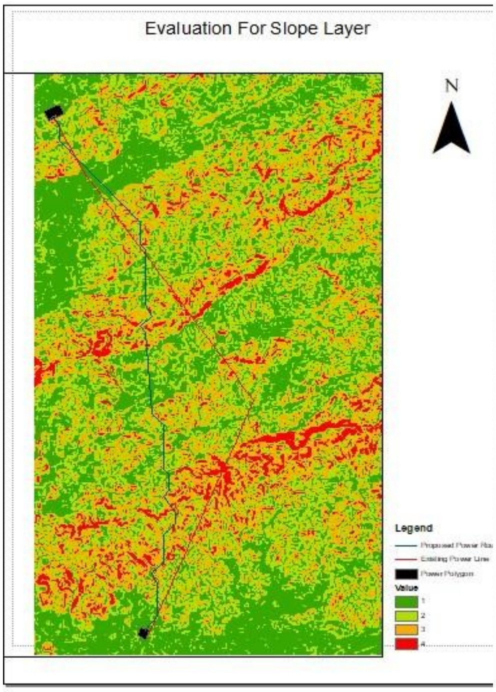

Figure 6: Evaluation of Slope Layer

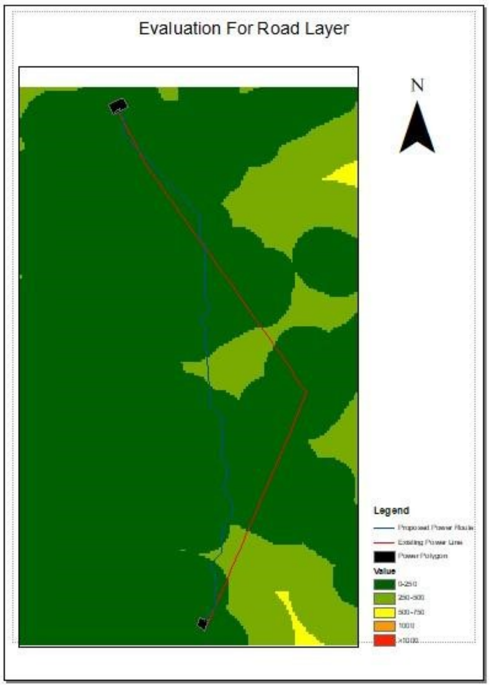

Figure 7: Evaluation of Road Layer

Source: Results of the Author's analysis

Evaluation of Residential Layer

Figure 8 depicts the housing layer rating criteria. The point density toolset is used to classify home density based on density. The transmission line should avoid areas with a high population density. Class 5 has the largest housing density in our analysis; however, neither the planned route nor the existing transmission line pass through this area. Because of the low house density, the route runs through class 1. There are also a few sections where the route passes through class 2 because only class 2 has a lower dwelling density.

Evaluation of Land Use Layer

Figure 9 depicts the land use layer rating criteria. Several types of land use are incompatible with construction. For this study, land use is divided into five categories: forest, water bodies, agriculture, urban, and bare soil. Water bodies have the highest scale value, although neither the proposed route nor the current transmission line must cross through the water bodies categories. Power transmission lines must be located far away from lakes or water bodies because lines located near water bodies can harm the habitat of the water bodies, particularly during silt deposition in water bodies during construction, among other reasons.

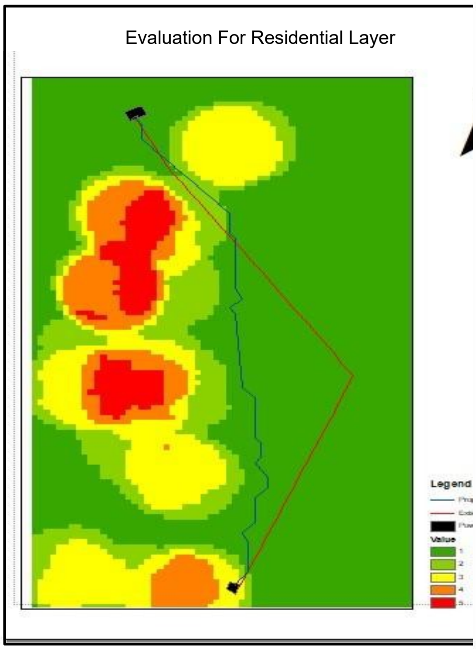

Figure 8: Evaluation of Residential Layer

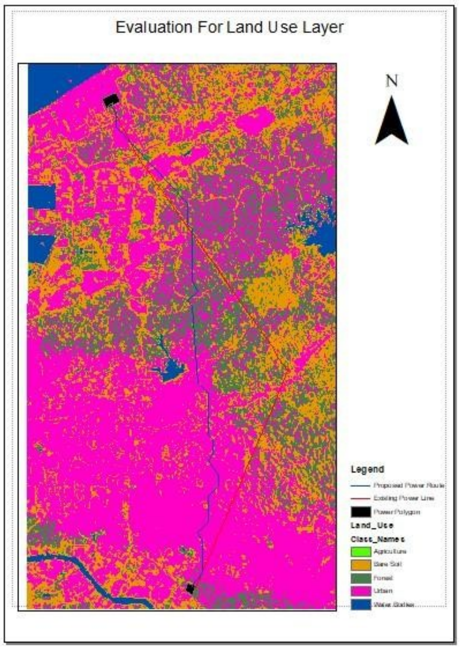

Figure 9: Evaluation of Land Use Layer

Source: Results of the Author's analysis

CONCLUSION

The study's three major goals are to discover a viable path to place a new transmission line using the Least Cost Path program. According to this research, the least-cost path analysis is particularly intriguing for power line routing since it is a quick and repeatable technique that allows the user to combine data from multiple sources. Various datasets have been classed into a similar class scale based on the routing criteria as GIS functions have advanced. These identified datasets are then weighted and aggregated to assess the appropriateness of a specific set of rules or parameters. GIS provides a wide range of software that can be applied in a variety of fields. It aids in the management and decision-making processes.

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POST OCCUPANCY ASSESSMENT COMPARATIVE ANALYSIS TOWARDS SUSTAINABLE TOWNSHIP DEVELOPMENT

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Abstract

Sustainable township development is the foundation of a sustainable society; however, the development of sustainable neighbourhoods as it currently stands will not permit all stakeholders, particularly end users, to effectively address current or anticipated unforeseen situations that are beyond the scope of physical development. Thus, it is crucial to determine if a pre-occupancy sustainable neighbourhood concept or a certified green project acknowledged sustainable dimension pillars (SDP) adaptive measures after occupancy. The purpose of the study was to identify the post-occupation township development's based on of sustainable criteria. The Stakeholders-Inclusion Approach and Post-Occupancy Evaluation Model were utilised as evaluation tools. This study's objective is to assess and classify the SDP gap in environmental, social, and economic responsiveness and balance methodology towards progressive developments in sustainable and resilient neighbourhood development at the community and individual levels. The respondents of this study are end-users or homeowners who have resided in these developments for over a year. In post-occupancy sustainable neighbourhoods, the findings revealed SDP adaptation gaps. As a result, it provides significant identified criteria measures for further improvement and refinement towards the development of a resilient and sustainable ASEAN neighbourhood.

Keyword: SDG11, Sustainable cities, Green Township, Post-occupancy Evaluation

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INTRODUCTION

A problem that affects the entire world is creating economically productive urban development conditions that are also environmentally sustainable and socially equally livable. According to recent forecasts, by the year 2030, the world will have developed into a global city rather than a global village, as was commonly understood in the past (UNEP-WGBC 2012). The city and its surrounding conurbation serve as a hub for anthropological livelihoods and economic development in addition to being the centre of economic activity and productivity. The development of cities or townships ought to be planned at the micro district level, which calls for evaluation and benchmarking of its operations; it ought to be economically viable and a sustainable living environment in addition to being socially fulfilling. It is anticipated that greening townships, districts, and eventually cities will be an extremely difficult challenge. It is without a doubt essential to have a solid understanding of the sustainable criteria and framework that can be gained from greening buildings. The prototype for the ideal sustainable neighbourhood should emphasise the significance of placing the pedestrian at the centre of urban planning and design concerns, while vehicular traffic should be viewed as a byproduct of these efforts (Pucher and Dijkstra 2000). Energy consumption is reduced, and as a result, fewer greenhouse gases are released into the atmosphere or environment. This is accomplished by putting an emphasis on communal living and encouraging activity within walking and cycling distances to access daily needs and engage in social interaction. Communities are connected to the natural world through the "green lungs," which include things like gardens, green parks, and playfields. Opportunities for employment and education, opportunities for residents to participate in civic life, and the provision of local facilities all contribute to an improvement in residents' social well-being (Woodcraft, Hackett et al. 2011). An initiative to encourage community carpooling, bicycle parking racks, and shower stations could all be potential criteria for the evaluation.

The importance and value of sustainable township development has been recognised by governments, local authorities, project developers, and communities throughout the ASEAN region; however, efforts must be consolidated into actions because a holistic approach to sustainable built environment, community, and economic development is rather complicated (Ding, 2008). Numerous rating criteria and evaluation tools for sustainable township development have been developed, and they are being revised on a regular basis for the purpose of improvement. Green Township indexing tools in ASEAN countries have identified the need for sustainable frameworks and guidelines for communities. The purpose of developing these sustainable frameworks and guidelines was to offer a path that is both clear and consistent for the formation of green or sustainable communities. In addition to this, it acts as a resource for local governments in terms of policy framework, the development and approval of projects, and, ultimately, sustainable urban development causes (Hezri 2004). However, with the exception of Malaysia, Singapore, and Indonesia, the majority of green evaluation tools in ASEAN lack sustainable township or neighbourhood pre-occupancy and post-occupancy evaluation tools aimed at end-users or households. This is the case even though Malaysia, Singapore, and Indonesia are considered to be leaders in this field (Yaman et. al, 2017).

MATERIALS AND METHODS

The Ken Rimba Development in Greater Kuala Lumpur, Malaysia, and the Parinyada Village in Bangkok Metropolitan, Thailand, are serving as the case studies for this investigation. Both of these communities are located in Malaysia and Thailand respectively. These case studies were selected because the stakeholders (end-users/homeowners) occupied them for more than a year prior to the study's beginning.

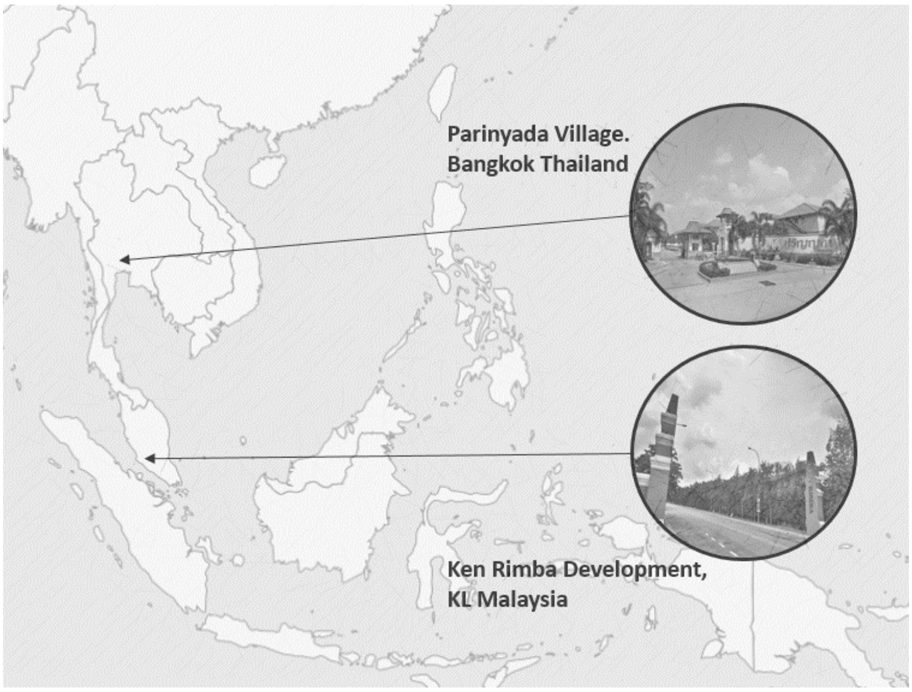

Figure 1: Case Study 1: Ken Rimba Development and Case Study 2 Parinyada Village
Source: Yaman, 2017

Study Area

Case study 1: Ken Rimba Development, Kuala Lumpur.

The development of the Ken Rimba neighbourhood is based on the concept of "the promise of beauty, luxury, and nature." Within the Klang Valley or Greater Kuala Lumpur, it is an integrated neighbourhood or township development located in the prime vicinity of Shah Alam. The Ken Rimba Commercial Centre, the Ken Rimba Legian neighbourhood residences, the Ken Rimba Jimbaran neighbourhood residences, and the two phases of the Ken Rimba Condominium developments make up this premium urban neighbourhood township development. The township development plot in the Ken Rimba neighbourhood is spread out over sixty acres of prime land with a freehold tenure and captures all of the luxury and seclusion that can be found. It is also the first green township in Malaysia, which has revolutionised the land-use change of an industrial area into a landscape paradise-like neighbourhood enclave in Shah Alam. This neighbourhood enclave can be found in Shah Alam.

Case study 2: Parinyada Village, Bangkok.

The components of Parinyada Village's development were dispersed across its three villages, of which there were two villages with townhouses and one village with single-family homes. The primary real estate development in the neighbourhood is called Parinyada Village, and it features both landed bungalows and the Village Clubhouse. The most prominent structure included in the development of this neighbourhood is the Village Recreational Clubhouse, which can be found right in the middle of Parinyada Village. It was the primary venue for social gatherings, and it also housed recreational facilities and other conveniences. Additionally, it was the most recognisable landmark in Parinyada Village. The second neighbourhood precinct, known as Parinlak Village, is a diverse community that consists of townhouses, residential units, office units, commercial areas, and recreational facilities. The third neighbourhood precinct is called Parinlak Light Village, and it features integrated components such as contemporary townhouse residences as well as a centrally located Clubhouse that features a dedicated swimming pool and recreational facilities. In total, there are 434 households, also referred to as property units. It is made up of 175 bungalow residences in Parinyada Village, 135 property units in Parinlak Village, and 124 residences in Parinyada Light Village.

The establishment of POEM Framework

The purpose of this planned POEM framework is to provide an evaluation measurable model for the effectual and sustainable urban neighbourhood development that addresses the limitations and gaps upon occupancy. This is significant because it will allow for an effective urban neighbourhood to be developed. The overall concept of the study was discussed in the POEM Handbook conceptual framework (Figure 3). (Figure 3). The POEM framework was utilised in this research project in order to take into account the fundamental dimension aspects of sustainable urban neighbourhood development. These fundamental aspects were centred on issues relating to the environment, society, and economy. The POEM framework is constructed on three different sustainable dimensions, all of which need to be cohesively integrated in order to accomplish the objectives that have been outlined for this proposal framework. Particularly, the environmental, social, and economic dimensions (Yaman et. al, 2016). (Yaman et. al, 2016).

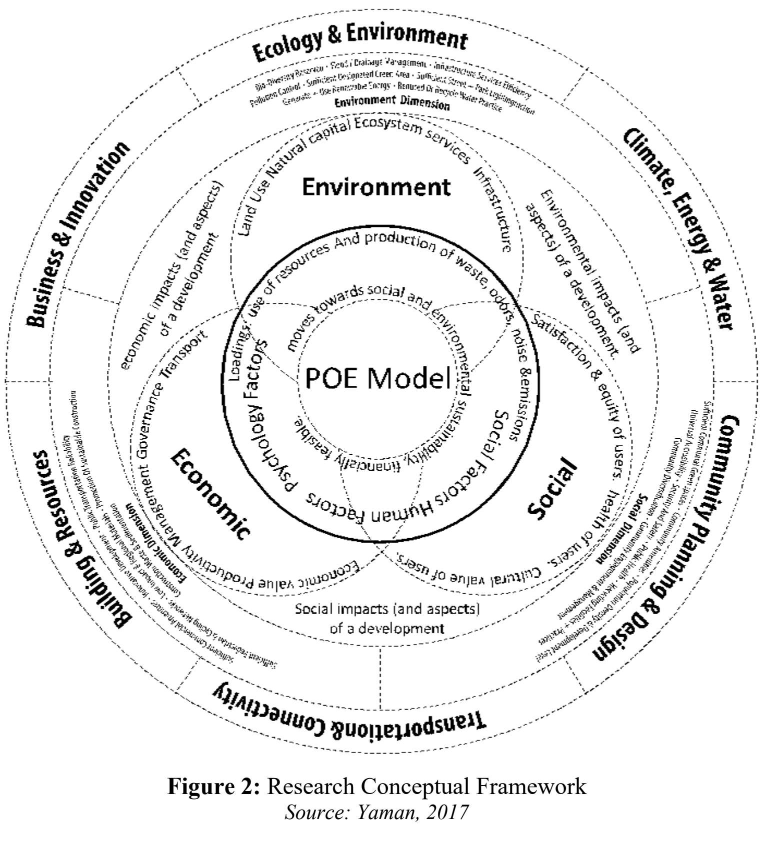

Figure 2: Research Conceptual Framework
Source: Yaman, 2017

The Stakeholder-Inclusion Approach is used in this study in order to gather households' opinion towards the POEM Handbook measurement criteria for sustainable neighbourhood development at community and individual level. It is developed to measure the sustainable indicators of green neighbourhood projects in this region and aims to address the underpinning research objectives: to evaluate and assess sustainability gaps through adapted sustainable dimensions of POEM framework; and how these sustainable gaps can be addressed and improved towards urban resilience (Yaman et. al, 2016).

Methods for Evaluating and Ranking POEMS
The POEM evaluation criteria were broken down into three categories, with the Environment Dimension Pillar consisting of a total of eight evaluation sub-criteria (EnP Q1-EnP Q8), the Social Dimension Pillar consisting of a total of eight evaluation sub-criteria (SoP Q1-SoP Q8), and the Economic Dimension Pillar consisting of a total of eight evaluation sub-criteria (EnP Q1-EnP Q8) (EcP Q1- EcP Q8). The scoring for the POEM Handbook can be found by using the following equation (Yaman, 2017).

As shown by the following equation, the score for each individual respondent's dimension is determined by dividing the total number of credits earned by the total number of credits available, then multiplying that result by the weighting:

$$\frac{Sc\_CR}{Av\_CR} \times W\ (100\%) = D\_SA$$

Sc_CR: Individual Scored Credits
Av_Cr: Available Credits
W: Weighting
D_SA: Dimension Scored Achieved

As shown by the following equation, the best way to summarise the total respondents dimension score achieved (tD SA) is to take the sum of the total respondents dimension score credits (tSc CR) and divide it by the total sampling (N):

$$\frac{tSc\_CR}{N} = tD\_SA$$

tSc_CR: total respondents Scored Credits
N: total respondents
tD_SA: total Dimension Scored Achieved

The rating benchmark are based on Table 1 below;

Table 1: POEM Framework Rating Benchwork

Scores	POEM Ratings	Description
86 to 100 TD-CA	Platinum	Beyond outstanding criteria ratings of POEM for Sustainable Neighborhood
76 to 85 TD-CA	Gold	Outstanding criteria ratings of POEM for Sustainable Neighborhood
66 to 75 TD-CA	Silver	Good criteria ratings of POEM for Sustainable Neighborhood
50 to 65 TD-CA	Certified	Fulfilled criteria ratings of POEM for Sustainable Neighborhood
Below 50 TD-CA	-	Failed criteria ratings of POEM for Sustainable Neighborhood

Source: POEM Handbook (2017)

RESULTS AND DISCUSSION

Figure 3 (Ken Rimba Development) and Figure 4 depict the POEM Handbook's findings regarding the perspective of end-users/households on post-occupancy evaluation criteria based on SDP dimensions (Parinyada Village).

Case Study 1: Ken Rimba Development

Based on the proposed POEM Handbook framework, the total dimension scored achieved (tD SA) of the current green neighbourhood of Ken Rimba development has been calculated as the sum of the final dimension scored achieved of the three (3) dimension pillars. This calculation was based on the framework that was proposed in the POEM Handbook. As can be seen in Figure 3, the post-occupancy evaluation of the green neighbourhood included in the Ken Rimba development found that it satisfies 54.2% of the tD SA of the POEM Handbook's evaluation criteria for the development of sustainable neighbourhoods. After conducting an in-depth analysis of this neighbourhood in relation to the three (3) Sustainable Dimension Pillars, criteria, and sub-criteria of the proposed POEM Handbook, this total tD SA was determined.

POEM Scoring Calculation Master Sheet.					
Q_ No	Criteria Coding	POEM Evaluation Criteria	Available Credits	Scored Credits	
Environment Dimension Pillar			Av-Cr	Sc-Cr	
1	EnP Q1	Sufficient Designated Green Area	610	311	
2	EnP Q2	Sufficient Street Or Park Lighting	610	316	
3	EnP Q3	Generate Or Use Renewable Energy	610	315	
4	EnP Q4	Reduced Or Recycle Water Practice	610	319	
5	EnP Q5	Bio-Diversity Reserved Availability	610	184	Failed to fulfill POEM Rating
6	EnP Q6	Flood / Drainage Clogging Experience	610	304	Failed to fulfill POEM Rating
7	EnP Q7	Infrastructure Services Efficiency	610	368	
8	EnP Q8	Pollution Control & Experience	610	307	
		Dimension Av-Cr / Sc-Cr	4880	2424	
		EnP Dimension Scored Achieved		49.6%	
Social Dimension Pillar			Av-Cr	Sc-Cr	
1	SoP Q1	Sufficient Communal Greenspaces	610	371	
2	SoP Q2	Population Density & Development Level	610	410	Good POEM Score Rating
3	SoP Q3	Universal Accessibility Availability	610	382	
4	SoP Q4	Security And Safety Experience	610	326	
5	SoP Q5	Public Health Concerns	610	407	Good POEM Score Rating
6	SoP Q6	Recycling Facilities Or Practices	610	357	
7	SoP Q7	Community Diversification	610	401	
8	SoP Q8	Community Engagement & Management	610	365	
		Dimension Av-Cr / Sc-Cr	4880	3019	
		SoP Dimension Scored Achieved		61.8%	
Economic Dimension Pillar			Av-Cr	Sc-Cr	
1	EcP Q1	Distance To Community Amenities	610	317	
2	EcP Q2	Public Transport Reliability	610	321	
3	EcP Q3	Sufficient Pedestrian & Cycling Networks	610	317	
4	EcP Q4	Low Impact & Regional Materials	610	210	Failed to fulfill POEM Rating
5	EcP Q5	Promotion Of Sustainable Construction	610	315	
6	EcP Q6	Construction Waste & Sedimentation	610	261	Failed to fulfill POEM Rating
7	EcP Q7	Sufficient Commercial Amenities	610	395	
8	EcP Q8	Innovative Development	610	368	
		Dimension Av-Cr / Sc-Cr	4880	2504	
		EcP Dimension Scored Achieved		51.3%	
		Total Dimension Av-Cr / Sc-Cr	14.640	7947	
		Sc-Cr (72) / Av-Cr (120) x Weighting (100%)		54.2%	
		Total Dimension Scored Achieved		**54**	

Figure 3: POEM Framework results for Ken Rimba Development
Source: Yaman, 2017

Four of the sub-criteria for each POEM Evaluation failed to meet the POEM rating. In this study, POEM Evaluation sub-criteria for EnP Q5 and EnP Q6 (Environment Dimension Pillar); and EcP Q4 and EcP Q6 (Economic Dimension Pillar) is below score rating. In order to address the sustainable gaps in SDP adaptive measures in the post-occupied sustainable neighbourhood, the four identified POEM Evaluation sub-criteria were used.

According to this study's findings, there is less concern about the importance of biodiversity and flood/drainage systems (based on EnP Q5 and EnP Q6 scores). Although the developers of the project are not very aware of the importance of maintaining the biodiversity and ecosystem in the development project, despite this sub-high criteria's importance in the Environment Dimension Pillar. The development of the Ken Rimba neighbourhood is lacking in protected biodiversity. Water bodies, such as rivers, tributaries, streams, lakes, ponds, and reservoirs, are not present in this area or mentioned in the EnP Q5 reference guide. Despite the fact that this neighbourhood has some greenery, end-users and households have the impression that it is insufficient. The hydrology management system is another problem that needs to be addressed because this area is low and downstream of the Klang River, making it vulnerable to flash flooding in the event of heavy precipitation. Findings for the Economic Dimension Pillar, EcP Q4 that fall below the certification level. Findings from the POEM Handbook's evaluation of the Economic Dimension Pillar indicated that less emphasis was placed on low-impact and local materials in Ken Rimba's certified township development (based on EcP Q4 score). The Construction Waste and Sedimentation sub-criteria also have a hole in them. As stated in the Ken Rimba township's pre-occupancy green features, the useful characteristics of "Australian" louvred windows that permit controllable continuous air flow across the interior space serve as an example of out-of-region materials that were used in this township development. Further consideration of the sub-criteria for transportation and connectivity as well as for materials and resources can be highlighted as another evaluation that supports the sustainable economic dimension. By improving pedestrian and bicycle connections and raising awareness of the materials and resources sub-criteria by promoting construction waste management and sustainable construction, additional work can be highlighted in the transportation and connectivity sub-criteria (Yaman et. al, 2017).

Case Study 2: Parinyada Village

The total tD SA of the current green neighbourhood in Parinyada Village has been confirmed to be equal to the sum of the final tD SA of the three (3) dimension pillars that were taken into consideration in the previous paragraph in accordance with the framework provided by the POEM Handbook. As can be seen in Table 4, the post-occupancy evaluation of the Parinyada Village development has demonstrated that it satisfies sixty percent of the tD SA set forth by the POEM Handbook evaluation criteria for sustainable neighbourhood development. In order to arrive at this tD SA, the proposed POEM Handbook's three (3) Sustainable Dimension Pillars, as well as its criteria and sub-criteria, were given careful consideration and evaluation.

According to this study's findings, there is a lack of consideration (based on the scores for EnP Q5, EnP Q3, and EnP Q4) regarding the significance of the preservation of biodiversity and ecology, energy efficiency, and water efficiency sub-criteria. Despite the fact that this sub criterion is of an equally high significance in the Environment Dimension Pillar, there is a lack of consideration on the part of the property developer in terms of preserving or conserving biodiversity and ecosystems; there is also a low awareness in the implementation of energy efficiency by generating and using renewable energy; and there is not enough effort taken in water efficiency through water recycling systems. The new neighbourhood development in Parinyada Village does not include any areas that have been set aside for the preservation of bio-diversity. The second factor contributing to the low score is insufficient energy efficiency. The findings from the majority of the end-users point to a deficiency in the generation of on-site energy sources as well as a deficiency in the use of renewable energy.

POEM Scoring Calculation Master Sheet.					
Q_ No	Criteria Coding	POEM Evaluation Criteria	Available Credits	Scored Credits	
Environment Dimension Pillar			**Av-Cr**	**Sc-Cr**	
1	EnP Q1	Sufficient Designated Green Area	155	112	
2	EnP Q2	Sufficient Street Or Park Lighting	155	129	Outstanding POEM Score Rating
3	EnP Q3	Generate Or Use Renewable Energy	155	65	Failed to fulfill POEM Rating
4	EnP Q4	Reduced Or Recycle Water Practice	155	86	
5	EnP Q5	Bio-Diversity Reserved Availability	155	57	Failed to fulfill POEM Rating
6	EnP Q6	Flood / Drainage Clogging Experience	155	126	
7	EnP Q7	Infrastructure Services Efficiency	155	129	Outstanding POEM Score Rating
8	EnP Q8	Pollution Control & Experience	155	132	Outstanding POEM Score Rating
		Dimension Av-Cr / Sc-Cr	1240	836	
		Dimension Scored Achieved		57.5%	
Social Dimension Pillar			**Av-Cr**	**Sc-Cr**	
1	SoP Q1	Sufficient Communal Greenspaces	155	84	
2	SoP Q2	Population Density & Development Level	155	76	
3	SoP Q3	Universal Accessibility Availability	155	63	Failed to fulfill POEM Rating
4	SoP Q4	Security And Safety Experience	155	141	Outstanding POEM Score Rating
5	SoP Q5	Public Health Concerns	155	104	
6	SoP Q6	Recycling Facilities Or Practices	155	77	Failed to fulfill POEM Rating
7	SoP Q7	Community Diversification	155	78	Failed to fulfill POEM Rating
8	SoP Q8	Community Engagement & Management	155	91	
		Dimension Av-Cr / Sc-Cr	1240	714	
		Dimension Scored Achieved		67.1%	
Economic Dimension Pillar			**Av-Cr**	**Sc-Cr**	
1	EcP Q1	Distance To Community Amenities	155	109	
2	EcP Q2	Public Transport Reliability	155	90	
3	EcP Q3	Sufficient Pedestrian & Cycling Networks	155	100	
4	EcP Q4	Low Impact & Regional Materials	155	111	
5	EcP Q5	Promotion Of Sustainable Construction	155	95	
6	EcP Q6	Construction Waste & Sedimentation	155	125	Outstanding POEM Score Rating
7	EcP Q7	Sufficient Commercial Amenities	155	116	
8	EcP Q8	Innovative Development	155	112	
		Dimension Av-Cr / Sc-Cr	1240	858	
		Dimension Scored Achieved		69.1%	
		Total Dimension Av-Cr / Sc-Cr	3720	2408	
		Sc-Cr (72) / Av-Cr (120) x Weighting (100%)		64.6%	
		Total Dimension Scored Achieved		**65**	

Figure 4: POEM Framework results for Parinyada Village.
Source: Yaman, 2017

The third criterion that needs to be addressed is the water efficiency criterion. The majority of the end-users believe that the neighbourhood does not have enough practices in place that reduce or recycle the amount of water that is used. According to the findings of the environmental dimensions, in order to improve the sustainable level of the neighbourhood, additional efforts need to be made, in particular to provide biodiversity and ecosystems within the neighbourhood. Additionally, attention ought to be paid in improving energy efficiency by implementing rooftop solar PV and improving water efficiency by practising water recycling and introducing a method of rain-harvesting. According to the perspective of end-users or households for the Social Dimension Pillar, the majority of the sub-criteria for which credit was gained are considered to have satisfied the minimum POEM Handbook evaluation criteria or have been certified with a score of 57.5 achieved. POEM evaluation sub-criteria SoP Q2, SoP Q3, and SoP Q6 were the only ones in which it did not meet the POEM fulfilled requirement. As a result, the findings of this POEM Handbook evaluation suggested that there is a significant gap regarding the absence of

Universal Accessibility in this neighbourhood development (based on the score for SoP Q3), Population Density & Development Level (based on the score for SoP Q2), and Recycling Facilities & Practices (based on the score for SoP Q2) (based on SoP Q6 score). There is not enough provision or measures that were given in supplying facilities for disabled people, there is an absence of neighbourhood diversification, along with a poor effort made in recycling programs and practices (Yaman et. al, 2017). As a result, in order to make advancements before the study's conclusion, these three (3) sub-criteria need to have further consideration given to them in order to raise the score on the social dimension criteria for this neighbourhood development. Prior to the conclusion of this investigation, in order to accomplish a greater POEM evaluation criteria score or to be urban resilient, more efforts and measured to be taken towards continuing sustainable neighbourhood agenda of this neighbourhood by strengthening sub-criteria score, in particular the Social Dimension Criteria and the Environmental Dimension Criteria. This neighbourhood also needs to have urban resilience.

CONCLUSION

The findings of this case study's POEM Handbook for SND on-site testing should be acknowledged that pre-occupancy guidelines for sustainable township/neighbourhood development sustainability level differ from post-occupancy evaluation perceived by end-users/households. The findings suggested that related issues or criteria in this study context were influencing the community's sustainability agenda as well as the larger context of the ASEAN region in various ways based on environmental, social, and economic dimensions. The identification of these issues through the implementation of the POEM Handbook for certified sustainable neighbourhood development will provide insight into the root cause of post-occupancy sustainable practises and resilience to stressed and shocked development. Because urban development is a permanent and irreversible environmental alteration, the findings from these two case studies may contribute to urban stresses that weaken the fabric of a city, such as high unemployment, an overburdened or inefficient public transportation system, endemic violence, or food and water shortages. Furthermore, it has the potential to cause severe urban shocks such as floods, landslides, and disease outbreaks. As a result, the POEM Handbook for SND will improve the community's neighbourhood context's sustainability and resilience (Yaman et. al, 2017). As a result, the application of POEM for SND in assisting the enhancement and further development of sustainable township/neighbourhood and to increase urban resilience in the ASEAN region via identified low score dimensional criteria and after-effect consequences would be argued in this study.

The empirical data in Table 1 also indicate a lack of pre-occupancy and post-occupancy evaluation criteria among ASEAN nations, with only Case

Studies implementing post-occupancy evaluation criteria in this research. As a result, the author would like to recommend POEM for SND in this study because its implementation will benefit (Yaman et al, 2017):

- Ongoing SD Agenda - From Pre-Occupancy to Post-Occupancy and Beyond
- Fostering Sustainable Practice at All Levels—from Conurbation to Township to Neighborhood to Community to Individual—with Specific Sustainable Dimension Criteria & Sub-Criterion
- Simplified and easy to understand at every level, and applicable to any post-urban neighbourhood development
- The planned sustainable outline and agenda of viable urban development expansion and urban resilience for the ASEAN Region should ensure that long-term goals are met in tandem with ASEAN 2025 and the UN 2030 Agenda for Sustainable Development. As a result of this study, there are numerous general recommendations, and the intended model framework. Grounds, in particular, play a significant role in effective implementation. The current sustainable neighbourhood/township scenario in the ASEAN region could be significantly improved by the supportive role outlined in this outcome. The following are key points to demonstrate the important recommendations (Yaman et al, 2017):
- All stakeholders involved in sustainable urban development, particularly green neighbourhood planning, should be involved in anticipating projected and physical indicators and emphasising general benefits to the relevant authority and institution in order to avoid objective redundancy and conflict of interests among participants in advance.
- The unsustainable business-as-usual practice particularly in the recent urban development need to be stopped, in specific act of completely transforming a brown-site form a virgin green-site in the name of making way of new urbanization. Sustainable evaluation through awareness and education coupled with conservation and preservation application of eco-system and bio-diversity reservations must be duly advocated. The sustainable measures are the fundamental compliances in evaluating sustainable urban development.
- Post Occupancy Framework for sustainable practice and management significance at individual and communal level via the accommodation of environmental, social and economic dimension issues and aspects (SDP Adaptations) need to be instituted by establishing awareness and educational programs and campaigns at every level towards progressing sustainable agendas of the constituents.

Future recommendations of this study are to carry out further research on other certified green development and more focus on each dimension pillar of environment, social and economic.

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SOCIAL HOUSING ALLOCATION IN SCOTLAND: THE ADVERSE SELECTION ISSUES

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Abstract

Since the social housing in Scotland is delivered through the public purse, ideally, the social landlords should allocate their stock efficiently to the right recipients. However, a social landlord may occasionally be subjected to adverse selection situations when applicants withhold certain information during the social housing application. Within the information theory spectrum, adverse selection stems from the belief that humans tend to act opportunistically by putting their self-interest first above others' interest. While there is ample evidence of vast adaptation of the information theory in different fields and sectors, there is still a remaining gap in the information theory application in understanding the actors' interaction in the social housing sector. By utilising semi-structured interviews with the housing officers from one case study, ten (10) housing officers from the case study in Aberdeen participated to share their views and experience during the pre-allocation stage. Three (3) broad themes were discovered which consist of withholding information, exploiting the loophole in the system and finally, lack of ways in verifying the information. Data has been analysed through a combination of thematic and content analysis. The thematic analysis primarily aims to establish common themes across settings. The content analysis is employed to support the thematic analysis by conducting a textual investigation and subsequently establishing the frequencies of the event shared by the housing officers. The findings yielded some noteworthy results that signified the matters commonly manipulated by the applicants, leading to adverse selection situations during the pre-allocation stage. It produces critical insights on the issues that the social landlord should thoroughly assess during the pre-allocation stage in improving their allocation practice. Predominantly, helping them to meet the right target recipients in the social housing allocation.

***Keywords**:* Adverse Selection, Housing Issue, Social Housing Allocation, Housing Management

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INTRODUCTION

Social housing allocation is a dynamic process involving different stakeholders from the pre-allocation up to the post-allocation stage. Ideally, there should not be a matter of concern between the stakeholders in the social housing allocation process if every interaction and conduct is in accordance with the institutional framework governing the social housing allocation determined by the legislation and policies.

However, this is not the case. Given the social sector's complex nature, the formal institutional framework, at times, cannot provide complete instruction and guidance for all eventualities. The effective operation of the allocation process could potentially fall short when adverse selection situations exist. Within the social sector formal regulations and conduct, in reality, due to opportunistic behaviours, actors may be driven to act out of their self-interest. Meanwhile the applicants could potentially adopt strategic behaviours to gain access to the social housing system.

These adverse selection situations created by the social housing applicants could subsequently lead to social landlords experiencing ineptitude in assigning social housing to the right target of recipients. As such, this paper aims to explore the adverse selection situations that could potentially exist during the pre-allocation stage from the housing officers' perspectives.

BRIEF OVERVIEW OF SOCIAL HOUSING IN THE UNITED KINGDOM

In an overview, social housing in the United Kingdom went through significant changes in its provision and intervention level. Changes in social housing provision were influenced by numerous factors which were primarily caused by the political affluent affecting institutional and governance arrangements for the social sector. For instance, due to the political power, it saw a significant shift in terms of social housing provision with the increasing participation of other Registered Social Landlords (RSLs) such as Housing Associations (HA), which traditionally have been dominated by the Local Authorities (Mullins & Murie, 2006). Progressively, it also saw that the Local Authorities' social stocks have significantly declined for several reasons. In addition to the political aspirations (mainly due to the Right to Buy policy introduction under Margaret Thatcher's reign), the limitation of new Local Authorities' dwellings construction also significantly contributes to the stock's decline. Also, it is essential to highlight that the social housing in the United Kingdom, in general, has been substantially transformed by major stock transfer from the Local Authorities (LA) to other Registered Social Landlords (RSLs) such as Housing Associations. In general, the large-scale transfer of ownership saw the capacity of other Registered Social Landlords (RSLs), particularly Housing Associations (HA), undertaking the primary functions in terms of housing provision and management functions in the social housing sector throughout the United Kingdom. Nonetheless, Local Authorities equally undertake the management roles and functions, particularly for their properties, within their jurisdiction. Thus, their remit towards the social housing sector still holds. They are responsible for the management aspects which include, letting for their houses (allocation), collecting the rents, properties' maintenance, as well as managing the tenancies (such as tenancy termination) and the environment in which their tenants are currently living. The UK's social housing provision also saw substantial deviations in terms of its institutional and governance arrangements, particularly on defining the target welfare group and how the allocation of social housing is being made in the UK to address the current needs.

THE SOCIAL HOUSING ALLOCATION PROCESS

Although there is variation in terms of the stage involved in the allocation process, the allocation process commonly involves these stages: admission to the list of applicants, determination of applicants' categories, identification of priority groups, assessment of priority within the group, and matching applicants with available properties. It is also imperative to note that every stage in the allocation process involves different actors, as depicted in Figure 1. Expectedly, the allocation process involves several other administrative teams, including housing officers, housing allocation team, and housing assessment team. Although different stakeholders equally are an important cog in the allocation process, nonetheless the paper only attempts to present the experience of the housing officers from the case study. Based on the stages identified, the housing officers are responsible to assist the applicant in Stage 1 and Stage 4.

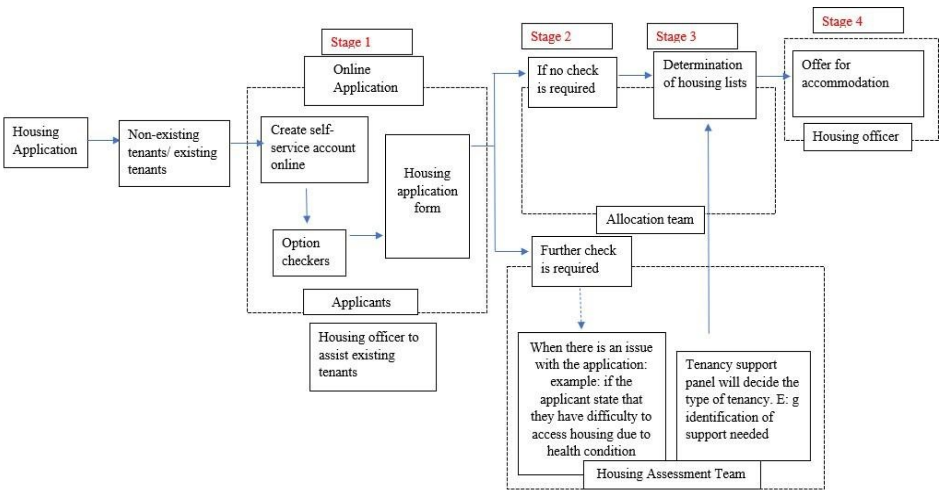

Figure 1: Housing Social allocation process (Author's illustration)

Stage 1 requires the applicants to create their self-service account within filling up their profile information to access the online application. Once the self-service account has been created, the applicants are required to go through option checkers to establish the chances being housed by the system through the priority level. Meanwhile, the final stage stipulates the accommodation offering procedure to the successful applicant. An offer is commonly made by phone and followed by house viewing arranged by a housing officer. Once viewing is completed, the applicant has to decide whether to accept the offer that has been made by the housing officer on behalf of the social landlord within 48 hours. Housing officers are also responsible to furnish the successful applicants with all the necessary information including the tenancy agreement, handbook, and financial assistance such as Housing Benefits.

LITERATURE REVIEW

There is an extensive discussion on the information asymmetry in different forms of economic activities involving different sets of economic agents, such as borrowers and brokers, investors and issuers and also salesman and consumers (Green, 2005) (Brueckner, 2000) (Lutzkendorf & Speer, 2005) (Behnk, Barreda-Tarrazona, & Garcia- Gallego, 2014). However, it was noticed that studies on information asymmetry tend to focus on the private housing sector rather than the social sector.

Within the social housing allocation spectrum, information issues have become main concern in application process (Orr, 2018). Meanwhile (Kullberg, 2002) found that a substantial portion of households only registered in case of future needs and was not seriously interested and as a result, many offered dwellings were refused by applicants. At the same time the numbers of people on the waiting lists may not reflect the accurate needs for housing. Besides that, limitation on social rented housing has encourage households to become as needy as possible either through becoming homeless intentionally or expressing dishonesty in the application process. For example, a household with employed adults is less likely to be allocated a social property than a household with unemployed adults because unemployment threatens the latter household with homelessness. Therefore, some potential strategies for accessing social rented housing would be to lose one's job or lie about being employed purposefully.

Generally, there are numerous factors that likely contributing to the presence of information asymmetry which, subsequently lead to public housing fraud (Zeng, Xiaofen, & Haizhen, 2017). The social landlords may suffer from information asymmetry when dealing with the potential applicants in the allocation process, in particular, when the applicants tend to withhold specific information, especially when the information is vital in determining the allocation outcomes. Subsequently, shielding certain information during the allocation process may influence the social landlords' decision-making and lead to inefficiency in allocation.

As such, this study attempts to offer some critical insights into how adverse selection could potentially exist in the social housing sector, particularly during the pre- allocation stage. In summary, through the available literature, it can be concluded that there is still a remaining gap in understanding information asymmetry, i.e., adverse selection, especially within the social sector spectrum.

RESEARCH METHODOLOGY

The study employed a qualitative method to gain insights from Ten (10) housing officers' experience. The numbers were deemed sufficient to produce some substantial findings based on these housing officers' vast experience. In general, the interviews adopted a semi-structured approach as research instrument. All the interviews gained through the face-to-face interview and the session were audio-recorded using both a smartphone and a tape recorder. The data collected was organized and prepared for further analysis, including verbatim transcription of the interviews and sorting out the information by using the NVivo Software. Following that, the transcriptions were then gone through several times to develop the familiarization, and frequencies, ultimately, grasp the sense of the data collected. A thematic and content analysis was adopted for the analytical purposes in identifying the data's implicit and explicit ideas (Clarke, 2017) and involve coding to establish common themes across settings (Creswell, 2014).

ANALYSIS AND DISCUSSION

The findings put forward several issues implying the presence of adverse selection situations during the pre-allocation experienced within the actual practice setting. The findings are structured and presented based on the textual investigation and the frequencies of the event discussed by the housing officers during the interview session. Six main issues were addressed by the housing officers and the quotations are included to shed some light on the actual event experienced by the housing officers in stage 1 and 4 as depicts in Figure 2.

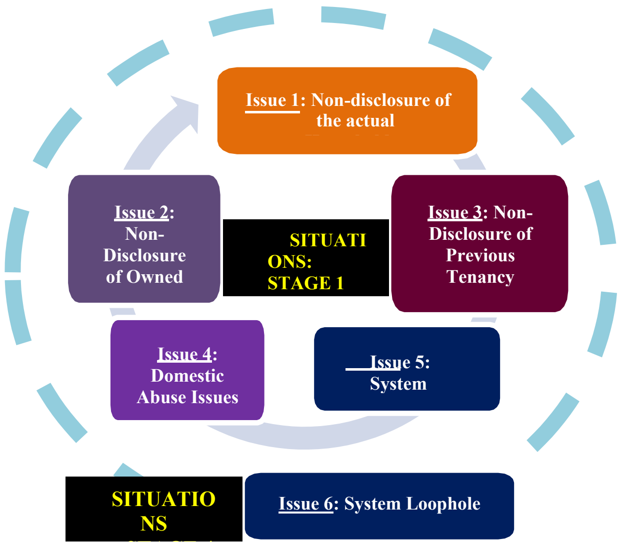

Figure 2. Six main issues were addressed by the housing officers

Issue 1: Non-Disclosure of Actual Household Information

The housing officers explained that the most common information that the tenants tend not to fully disclose is the actual households' information. The housing officers from the case study excerpted:

- "Someone subtly bending the truth. For example, a single man looking for a two-bedroom property would likely be a single man claiming that he shares custody with his ex-partner, and we have to give him a two-bedroom property since he claims that he has joint custody to look after the child. However, perhaps, in reality, he rarely sees the children. That tend to be the subtle things rather than a major problem such as identity fraud, or anything like that" (H1)
- "There are people that lie about children. They put down that they need two bedrooms because they have this child living with them. it is partial custody. The child is only with them 2-3 days a week" (H3)

In this instance, adverse selection could potentially exist when the tenants strategically distort the facts or information shared with the case study. The acts of lightly distorting the facts may benefit the applicants in the following term. Without proper checking, this suggests that one trajectory for the applicant to exploit the system is by stating that they are experiencing a shortage of bedrooms based on the household information presented during the application process. This subsequently could potentially increase the applicant's chances of being housed by the case study. Additionally, the transfer or moving-in process will be expedited by the case study, given that overcrowding issues are considered one of the main issues that should be ideally curbed and prevented in the social sector legislation.

Issue 2: Non-Disclosure of Owned Property

From the findings collated, the other type of information often withheld by the applicants during the pre-allocation is about owning property. According to the housing officers, the applicants have the tendency not to disclose that they have other property elsewhere. During the application stage, the applicant needs to disclose whether they have another property. However, some of them strategically chose not to reveal this imperative information. The housing officers from the case study claimed:

- "Applicant did not disclose she owned a property…." (H10)
- "We had a girl who had a baby, and she was allocated two bedrooms property. I went to see her, and I was advised that she owned a property that she had bought through shared ownership with [housing association], but she told us she does not own any property" (H2)
- "Somebody was coming in and applied for a house. Husband and wife with three children, but when it comes down to it, the wife and children live in the house that they own in Europe, they have a property, but they come to this country, and we are very soft in allocation property, and it turns out the family has no attention to moving, and we have already allocated the property to the husband" (H6)

Based on the extract above, the applicants tend to not disclose their information on owning a property. Not disclosing that they owned property would influence the allocation as it can intensify the applicant's chances by increasing their awarded points in the allocation mechanism.

Issue 3: Non-Disclosure of Previous Tenancy Record

Another housing officer shared that there are times when applicants do not disclose that they were formerly social tenants. Interestingly, the findings suggest that the applicant might re-enter the system by applying their partner's (ex-partner) name for a new allocation, particularly, to avoid paying their existing debts. The housing officers stated:

- "A lot of people said they have not been a social housing tenant before and have no debt with the organisation. The rent arrears they could own, thousands and they apply as a new/not a social housing tenant…." (H1)

- "…a man who claimed he was recently split from his partner and had three children that are going to stay with him, so he got allocated. 2 – 3 bedrooms property, pretty quickly under his name. The property that he just moved out from would be under the partner's name, and they could own us £2000-£3000…" (H7)

The findings suggested that, to avoid paying the debt, applicants will attempt to re-enter the system by submitting a whole new application. Again, there is a presence of adverse selection in this situation as the applicant may engage in this strategic behaviour in such a way by not disclosing their previous tenancies history, subsequently would increase their chances to re-access the social housing sector. According to the housing officers, this can be traced based on the applicant's basic information, such as date of birth and national insurance number, to verify the information. Nonetheless, the housing officers admitted that, at times, some might slip through the system's loopholes.

Issue 4: Domestic Abuse Issues

Adverse selection can also occur when the information shared by the applicants involves sensitive issues such as domestic abuse or violence. In this particular situation, it is extremely difficult for the housing officers to validate the information given. Occasionally, they would check the information with the relevant authorities. For example, whether the tenants have made any report to the relevant authorities about the alleged abuse to corroborate the information given. As excerpted by the housing officers:

- "Another example would be domestic abuse. We have to take domestic abuse seriously. We have to put them in temporary accommodation if they needed, but there have been circumstances where people have used that just to get another house" (H5)
- "… things like domestic violence, not everybody reports it, so again, we have to be a little bit sensitive to that. We cannot assume that it does not happen if they do not report it. So, I think this [domestic abuse] can be manipulated a bit. (H6)
- "You do not really know until later on. So, I had one couple of years ago where a woman came in and said, "I have been abused", and I cannot go home. So I said ok, I put you in temporary accommodation, got an offer for her, a brand new house, months later, the boyfriend moves in, so you are not sure whether or not they were lying the whole time or maybe they just got back together, you are not quite sure, but it gets you to think if it happens more than one [domestic abuse], well it is difficult one, it is hard to prove, but you kind of have to take what

they said because it is not my job to probe, I have just had to accept it" (H7)

Due to the complexity of domestic abuse cases, which may involve physical, emotional, economic or physical actions and threats toward the person who is being abused, the housing officers commonly take the information at par value without further detailed questions for sensitivity purposes. As such, the domestic abuse situation, on occasion, leaves room for manipulation by the applicants in the social housing system.

Issue 5: System Loophole

Following the importance given in the social housing legislation, which is to provide housing for a reasonable preference group, including the homeless, there might be a tendency for people to manipulate the system by intentionally presenting themselves as homeless to increase their chances of being housed. Without appropriate checking on the information, the applicant might slip through the safety net, which would afterwards cause an inefficient allocation in the system. As shared by one of the housing officers:

- "People generally lied on a homeless application, so they present themselves as a homeless, they said "this is their circumstances, then an offer came up, I meet them, when I speak to them, they said something and I said "that is not what it said in your application" (H4)
- Interestingly, one of the housing officers shared the experiences she had encountered in her job. Exploiting the system stretched beyond a bit of disinformation, and she further explained that sometimes people create an entirely different history about themselves.
- "Well, it is not unusual for people to turn up and their name is John Smith and gave us the entire history, filling in the online application, they could be anybody (H7)

She further continues:

- "...you just apply. They could be anybody. The only time we are asking for identification is when they come in. When they are being offered a property and for a lot of people the single man, they could come in with a current bank account, and that is it, and they got no photographic identity, but they could borrow that from any of their friends. So, we do not have a robust vetting system to ensure that the person we are talking to is that person. One of my colleagues who is doing the lease singing asked me to come in as a witness (for signing), and I said, 'Hi Jimmy, how are you?' I have not seen you in ages. You are getting a new flat?' and then my colleagues said his name is not Jimmy, it is Peter! (H7)

Following that substantial weight is given to preventing homeless in the social housing system in Scotland, at times, applicants could potentially manipulate the route to gain access to the social housing system. In this instance, the result further points out the importance of information verification during the application stage to minimise [11] the room for manipulation by the applicants.

ADVERSE SELECTION SITUATION IN STAGE 4

Issue 1: System Loophole

Based on the findings, one (1) main issue was highlighted to transpire in Stage 4. The presence of adverse selection during Stage 4 can be identified in the following condition. First, the housing officers addressed that people commonly exploited the financial assistance they were eligible to receive. In particular, the Housing Benefits. In brief, the case study manages the Housing Benefits on behalf of the Scottish Government to assist people in paying their rent. As the housing officers excerpted:

- "Housing benefit frauds definitely a big one" (H7)
- "I also have people in the one-bedroom property, and the partner's lives there, claiming housing benefit, saying she lives alone, she has Council tax discount, single person discount" (H2)

Following the non-disclosure of the actual information presented to the social landlord, it may lead to other issues involving the application of Housing Benefits. For example, the applicants are entitled to receive Housing Benefits and Council tax reductions together based on their chosen information shared with the social landlord. In this instance, adverse selection situations can potentially exist as the applicants seek to gain benefits by claiming more than they are entitled to by shielding information such as the actual number of households to increase their chance of receiving more generous payments from the government. The concern raised by the housing officers is in tandem with the data published by Audit Scotland (2020). It is estimated that the overpayments of HB due to fraud, had increased between 2015 and 2016 from £1.28 billion to £1.46 billion. In which the adverse situation may significantly impact the social landlords in terms of financial losses. Overall, through the findings collated, the adverse selection situation can be clustered into three (3) major themes:

Table 1: Themes identified in the pre-allocation stage.

Adverse selection category	Adverse selection situation
1. **Theme 1:** Withholding information	• Non-disclosure of the actual status of household information • Non-disclosure of property owned • Non-disclosure of previous tenancies and records
2. **Theme 2:** Exploiting the loophole in the system	• Strategically exploiting the system by declaring oneself as homeless,

CONCLUSION

Based on the findings, there are six key matters addressed by the housing officers that possibly implicate adverse selection situations in a pre-allocation setting. Firstly, it includes the non-disclosure of the actual status of household information, non-disclosure of property owned, and non-disclosure of previous tenancy records. Secondly, applicants, occasionally, exploit the system by declaring themselves as homeless and to some extent, create an entirely different profile to regain access to the social housing system. Thirdly, the information or issues are challenging to verify, especially when it involves sensitive information and cases related to domestic violence issues. Based on these findings, it can be further clustered into three (3) major themes, namely, withholding information, exploiting the loophole of the system and finally, lack of way in verifying the information.

The findings correspondingly display the importance of better screening, more sophisticated contracts and systems engaged by the social landlord as a safety measure in protecting their allocation, and ensuring the ability in meeting the right recipients. Also, implicitly, it further implies for more effective punishments or disincentive mechanisms to be considered in order to discourage applicants from exploiting the system. It further shows that the social landlords perhaps, should accentuate the level of verification and mechanism, incredibly in validating the information presented to the social landlord by the applicants during the pre-allocation stage, to ensure the efficiency during the pre-allocation stage could be further improved.

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THE EFFECTS OF COVID-19 ON RESIDENTIAL PROPERTY PRICES IN MALAYSIA

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Abstract

The physical distancing, lockdown, and other measures due to the COVID-19 pandemic have caused massive job loss and economic hardship, which would result in people not being able to pay their mortgages or rent. Thus, the main objective of this study is to examine the effects of the Gross Domestic Product (GDP), inflation, investment, and interest rate on residential property prices in Malaysia before and during COVID-19. This research utilises the annual time series data from 1990 to 2020, and the empirical analysis is conducted using the multiple linear regression analysis modelling approach. The finding shows that GDP and interest rates are positive and statistically significant with residential property prices. Practitioners can use these findings to understand the pandemic's effect on house prices. This will provide some guidelines for a policy formulation to moderate the increase in residential property prices to maintain the country's economic stability and indirectly help the government realise its vision of becoming a high-income country between 2024 and 2028. This is the first study that examines the pricing behaviour of Malaysian house prices concerning the COVID-19 shocks. In addition, the study contributes to regional housing price studies by bridging the real estate literature gap.

***Keywords**:* COVID-19, GDP, inflation, interest rate, residential

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INTRODUCTION

The world was already witnessing the trend of accelerating housing prices rising faster than salary and wages increases in many urban areas around the world (Wetzsein, 2017). Empirical evidence showed that housing markets have been susceptible to macroeconomic conditions (Allen-Coghlan & McQuinn, 2021). At the end of 2019, the COVID-19 pandemic began and has severely impacted worldwide economic activities. House prices (year-on-year) in many countries increased substantially after the outbreak of COVID-19 (Wang, 2021; Knight Frank, 2021) despite the negative growth rates of gross domestic product (GDP), high unemployment rates, and halted businesses. It was posited that the increase resulted from measures of cutting interest rates by central banks worldwide (Sahin & Girgin, 2020).

Malaysia's economy has also been adversely affected by COVID-19, and the subsequent movement control order (MCO) was implemented to flatten the pandemic curve. The economic contraction of 17 %in Q2 2020 was the steepest Malaysia has ever experienced (Kadhim et al. 2021). The National Property Information Centre (NAPIC) reported that around 33,000 units of properties were unsold for more than six months in the first half of 2019. Even worse, the house price between the range of RM201,000 to RM300,000, categorised as affordable to purchase by the Housing Ministry of Malaysia, showed the most unsold property, followed by homes priced at RM300,001 to RM400,001, respectively. Almost a third of the unsold houses are below RM300,000. Furthermore, these properties also did not match market requirements as they are often far from city centres, lacking connectivity and public transportation, eventually making them unappealing to potential customers.

Residential property prices boom over the years resulted in unsold housing properties. Despite this problem, overbuilding the house is a normal phenomenon in Malaysia. Developers tend to ignore this situation, which contributes to the decrease in the housing price index, as shown in Figure 2 (Delmendo, 2020). Although the housing price index relatively increase over the years, as shown in Figure 1, in terms of changes, it showed a decreasing trend due to overwhelming unsold residential properties.

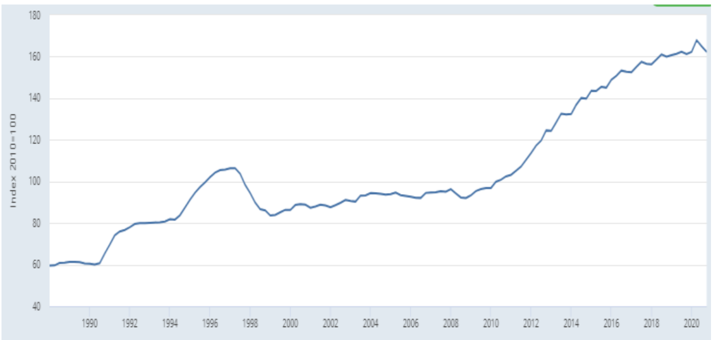

Figure 1: Real Residential Property Prices for Malaysia, Base Year 2010
Sources: FRED, Economic Data, 2020

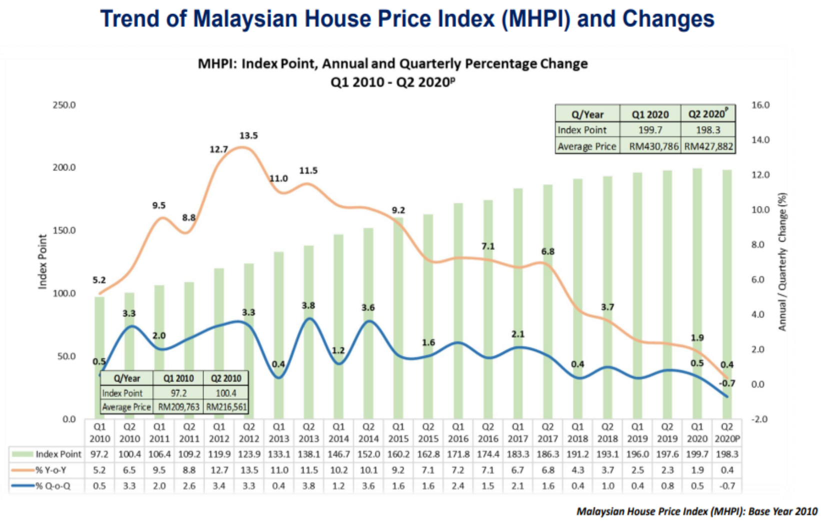

Figure 2: Trend of Malaysian House Price Index (MHPI) and changes
Source: National Property Information Centre (NAPIC), 2020

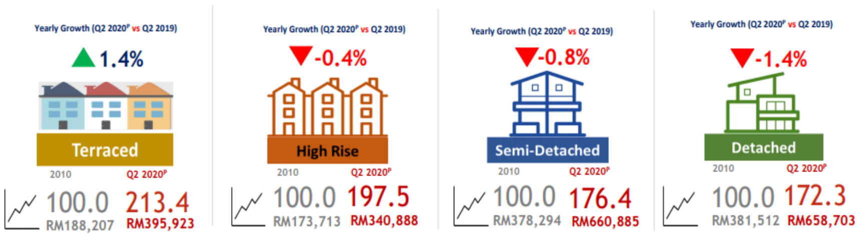

Figure 3: Malaysian House Price Index (MHPI): Base Year 2010
Source: Malaysian House Price Index (MHPI): Base Year 2010

Based on Figure 3, with 2010 as the base price, reflects the decreasing trend in the house price index based on estimated Q2 2020 compared to Q2 2019. However, only terraced houses showed an increasing trend compared to other residential properties. Although the housing markets are expected to be impacted by the economic downturn of COVID-19, this paper attempts to provide empirical evidence on the immediate impact of COVID-19 by examining the relationship between house prices and macroeconomic factors.

LITERATURE REVIEW

Pillaiyan, S. (2015) estimated the impact of real GDP, money supply, the stock market (KLSE), average bank lending rate, inflation (Consumer Price Index), consumer sentiments index, business confidence index, and loan approvals on housing prices. The time series used spanned quarterly data from 2000 to 2010. The study exerted a cointegrating vector error correction model (VECM) developed by Johansen (1988) to determine the number of cointegrating relationships among the seven variables. As a result, it discovered that housing price is positively affected by money supply, the stock market (KLSE), and the number of housing loans approved in the long run. In addition, the study examined that inflation (Consumer Price Index) and bank lending rates negatively affected housing prices.

The Engle LM, and an Autoregressive Conditional Heteroscedasticity (ARCH), were used by Reen and Razali (2016) to investigate the volatility clustering effect and volatility of house prices in three main urban areas in Malaysia. The study used panel data for 9 years from Q1 2005 to Q4 2013. The results indicated that the Base Lending Rate (BLR), GDP, housing stock, and inflation rate significantly impact the volatility of house prices. At the same time, more than half of the housing in Malaysia showed a volatility clustering effect, especially in three main urban areas in Malaysia.

Mariadas et al. (2020) determined the relationship between housing price and gross domestic product, interest rates, population, inflation, money supply, aging population, and stock market price in Malaysia from 1988 to 2017. Using the Autoregressive Distributed Lag (ARDL) modeling approach, all variables were statistically significant with house prices in the long run. Meanwhile, Trofimov et al. (2018) estimated the link between residential property price or known as the House Price Index (HPI) as the dependent variable, and Base Lending Rate (BLR), Consumer Price Index (CPI), Household Income (HI), population growth and Gross Domestic Product (GDP) as independent variables. Three techniques were used in this study: Johansen-Juselius cointegration, unit root and VECM-based Granger causality tests, and variance decomposition. The data used was quarterly for the period 2000-2015 period. The study found that residential property prices are associated with population growth, low-interest rates, and CPI increases. On the other hand, GDP and HI do not associate with property price growth.

Using a multiple linear regression model, Zandi et al. (2015) found that the BLR, GDP, and inflation rate positively correlated with housing prices in Penang, while GNI was the only independent variable depicting the negative relationship with housing prices. On the other hand, Baharuddin et al. (2019), using the multiple regression method and the Vector Error Correction Model (VECM), found that the GDP showed a positive relationship with housing prices while the inflation rate and interest rate showed a negative correlation between quarter 2005-2019. Also, in the long run, independent variables like GDP, interest rates, and inflation rates are significant in housing prices.

Kiong and Aralas (2019) investigated the impacts of housing prices on macroeconomic indicators such as Gross Domestic Products (GDP), Housing Stock (HS), interest rate, Global Financial Crisis (GFC), Population Growth (POPG), Inflation Rate (INF), and Exchange Rate (EXR) in Malaysia from Q1 2007 until Q4 2017. The Autoregressive Distributed Lag Model (ARDL), Error Correction Model (ECM), Dipasquale, and Wheaton Model were used. The research indicated a long-run relationship among the variables except for GDP. In contrast, GDP and FC demonstrated short-run relationships with housing prices.

In Kenya, Akumu (2014) estimated the link between constructed residential houses' new prices against domestic interest rates, Kenya shilling US dollar exchange rate, public debt, money supply, inflation, gross domestic product, and rental income. The data used was quarterly for Q1 2000 to Q4 2010. Multiple linear regression analysis was applied for this study. The results indicate that gross domestic product, money supply, and public debt positively affect housing prices. However, the rest of the variables negatively affected housing prices.

Previously, other researchers thought buyers' affordability to own a house was the sole factor affecting housing prices. However, according to Abdul Latif et al. (2020), the relationship was viewed broadly. Therefore, they probed the relationship between housing prices in Malaysia and macroeconomic drivers such as Foreign Direct Investment (FDI), Gross Domestic Product (GDP), interest rate, unemployment, and inflation. Therefore, the government and policymakers must make choices by understanding the variables influencing Malaysian housing prices.

FACTORS INFLUENCING RESIDENTIAL PROPERTY PRICES IN MALAYSIA

This study examines four factors influencing residential property prices in Malaysia. These are Gross Domestic Product (GDP), inflation, interest rate, and investment, which are discussed below.

Gross Domestic Product (GDP)

Gross domestic product (GDP) is one of the most popular measures to assess a country's economic wealth. The computation of a country's GDP considers various economic elements, such as consumption and investment. GDP is undoubtedly the most frequently followed and significant economic measure for economists and investors since it represents the total dollar worth of all products and services generated by an economy over a certain period. GDP is stated in two ways: nominal GDP and real GDP. Nominal GDP is based on current market values and does not account for inflation or deflation. Nominal GDP examines the natural movement of prices and monitors the gradual growth in the worth of an economy over time. Inflation is factored into real GDP, which accounts for the overall increase in price levels. Economists typically compare a country's economic growth rate using real GDP. They use real GDP to determine if there has been any growth from one year to the next. It is computed using goods and services prices from a base year rather than current values to adapt to price changes.

The gross domestic product is one of the variables that influence house prices, and it is well known that if house prices rise, the wealth level fall (Abdul Latif et al., 2020). Conversely, wealth impact will likely increase consumer expenditure when wealth levels grow, resulting in higher aggregate levels. As a result, demand is expected to rise, resulting in a rise in Real GDP and a faster pace of economic expansion. However, GDP has no direct influence on housing prices. If the property market ever collapses, it will spread across the economy, causing the GDP to decline.

Residential property is an essential requirement for many Malaysians. Unfortunately, only a few of them could afford it. If the government decides to boost household credit one day, demand for housing will dry up, leading to a drop in residential investment. (Abdul Latif. et al., 2020). Case et al. (2000) and Wit and Dijk (2003) define real GDP as the primary predictor of real estate cycles. According to Zhu (2004), real GDP growth incorporates data from other more direct family income indicators, such as unemployment and salaries. Tze (2013) discovered that real GDP is the primary determinant of Malaysian home prices.

Malaysia's real GDP in 2020 was 376,654 million US dollars. Malaysia's real GDP increased significantly during the previous 50 years, growing from 22,776 million to 376,654 million US dollars at an increasing yearly rate that peaked at 11.70% in 1973 and then fell to -5.59% in 2020. The trend of Real GDP from 1960 to 2020 is shown in Figure 4.

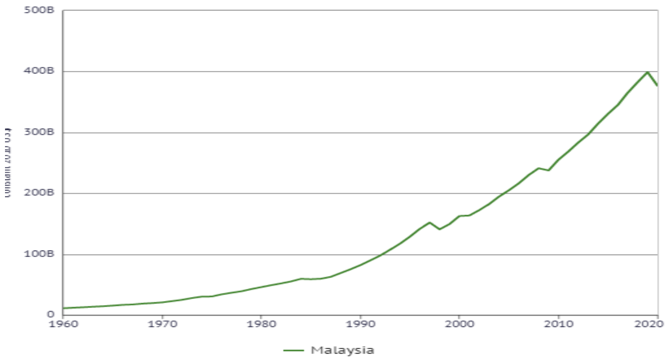

Figure 4: GDP (Constant 2010 US$)
Source: Department of Statistics Malaysia, 2020

Inflation

From 2005 to 2015, Kuala Lumpur property values pitched by nearly 122% (73% inflation-adjusted). In comparison, domestic price increases have been more discreet. From 2005 to 2015, Malaysia's house prices rose by 96.1% (52.4% inflation-adjusted). From 2016 to 2018, nationwide house prices rose by an annual average of 5.2% (3.3% inflation-adjusted). However, the housing market finally lost steam last year as the government's market cooling measures took effect (Delmendo, 2020). Unsold apartments in Malaysia's metropolises are now valued at RM 8.3 billion (US$ 1.9 billion), resulting from the rigid construction of top-end houses throughout the latest thriving (Delmendo, 2020).

Inflation is frequently indistinct as a continuous rise in prices for various services and goods. Economists clarify that price increases are the sign, not the root, of the problem. The fundamental reason for inflation is currency depreciation, which is consequently affected by increased printed currency in the market. Recently, several papers cited the effect of inflation on the housing market and prices. For example, Zandi et al. (2015) note that rising inflation increases residential property prices. On the other hand, Pillaiyan, S. (2015) mentioned that house prices have significantly inclined above the market value, influencing the inflation rate and hiking. However, the research conducted by Zandi et al. (2015) indicates that the inflation rate is not a significant variable of the residential property price.

Pillaiyan, S. (2015) argues the correlation between inflation and interest rates, the house price is related to the rental market, and the use of deposit-taking as a guarantee to the owner that the tenants will stay for a certain period that was agreed upon upfront for both parties. The critical point of his paper was that the market value depends on the inflation ratio to the real interest rate. Therefore, even when the banking institutions continue to announce a new level of the inflation rate, the actual price of sales to choose increases if the real interest rate declines. This result increased the knowledge of the rise of residential prices despite stabilized prices. Significantly supporting the relationship, it may be practical to slow down the new level of inflation rate in the market so that the real interest rates decline continuously if the community requests to reduce its adverse effect on the wealth circulation between landlords and tenants.

Interest Rate

Many more elements influence property values in the economy, and the relationship is not as protruding as in the previous sample. One of the other significant determinants is triggering house prices to rise in interest rates. For example, Nguyen (2020) found that low-interest rates result in more reasonable purchasing of homes price and escalate the demand for houses. If the housing supply is stagnant and the demand increases, the cost of places will rise. In big capitals where land accessibility is frequently restricted, inflation has a more prominent consequence.

Interest rate risk is mainly abided by individuals and organizations, and monetary policy transfers through debtors' balance sheets, with concerns for expenditures and shares (Hoffmann et al., 2019). Next, the distribution of interest rate risk is essential for financial strength. Determined acquaintances in the banking segment can contribute to concurrent bank defaults, increasing interest rates severely. Two differing understandings regarding banks' acquaintance with interest rate risk can be measured. Conferring to the "conventional opinions," banking institutions give away long-term facilities with short-term repayment. This short-period repayment system results in a rising risk of the interest rate. Under an initiative called "contemporary opinions," banking institutions deal with the interest rate risk exposure of their properties with that of their accountabilities and thus avoid interest rate risk (Hoffmann et al., 2019). Banks have better performance due to longer variable-rate loans by the debtors. Fluctuations et al. (1993) discuss the role of that deposit as term liabilities efficiently because banking institutions can exercise market power. They thus optimally invest in long-term assets such as properties. This leads to increased monetary stability for the banking institutions.

Investment

A company's capital investment is in the form of money to achieve its organizational goals and objectives. Gross capital formation (also known as a gross domestic investment) consists of outlays on additions to the fixed assets of the economy, plus net changes in the level of inventories. The concept can also apply to purchasing long-term assets such as real estate, industrial plants, and machinery by an organization. A capital investment can be made with cash on hand, by selling other assets, or by raising funds through the issue of debt or stock. There is no such thing as a minimum or maximum capital investment. It can range from less than $100,000 for a startup to hundreds of millions of dollars for large projects done by corporations in capital-intensive industries such as mining, utilities, and infrastructure. Capital investments are often used to improve operational capacity, gain a competitive market advantage, and generate more profit. For the same reasons, the firm may invest an equity share in another company's complementary operations.

Previous studies, such as Abdul Latif et al. (2020), used Foreign Direct Investment (FDI), which only focuses on foreigners investing in estates and property in a country. In Malaysia. FDI is the one that drives up prices more in local authorities with more considerable house price-earnings elasticity, which is one with less elastic housing supply. Additionally, FDI reduces homeownership rates, suggesting that residents may be priced out of the market in areas where foreign investors are more active and must rent rather than own homes. In this study, we used capital investments or, in other words, gross capital formation (also known as a gross domestic investment), which is way different from previous studies. This is because the data is more accurate than FDI as it combines foreign and domestic investment entirely for capital.

Malaysia's gross capital formation in 2019 was 76,738 million US dollars. Malaysia's gross capital formation grew from 676 million US dollars in 1970 to 76,738 million US dollars in 2019, rising at an annual rate of 12.56% on average. The trend of Capital Investment (Gross Capital Formation) from 1970 to 2020 is shown in Figure 5.

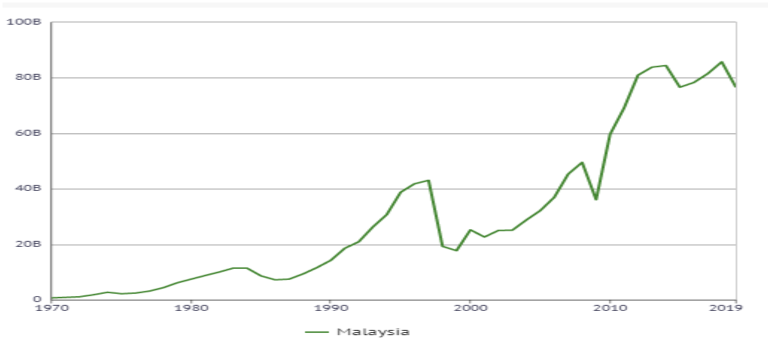

Figure 5: Gross Capital Formation (Current US$)
Source: Department of Statistic Malaysia, 2019

RESEARCH METHODOLOGY

This study employs an experimental technique. The objectives are to examine the influence of GDP, Inflation, Interest Rate, and Investment on Residential Property Prices in Malaysia before and during COVID-19. Multiple Linear Regression (MLR) was done to test the relationship between Residential Property Price, GDP, Inflation, Interest Rate, and Investment, as shown in Figure 6. All data used are annual observations of the variables, and the estimation period is 1990–2020. Annual data for all variables are obtained from the World Bank.

Figure 6: The relationship between the residential price and other economic factors

Hypothesis:

H_1: The real Gross Domestic Product (GDP) positively influences residential property prices.
H_2: The inflation rate (INF) positively influences residential property prices.
H_3: The interest rate (INT) positively influences residential property prices.
H_4: The investment (INV) positively influences residential property prices.

The following model specification is used to investigate the relationship between residential property price, Gross Domestic Product (GDP), inflation (INF), interest rate (INT), and investment (INV) in Malaysia Before and During COVID-19:

Regression Model: $HPI= GDP + INF + INT + INV + e$,

where:
HPI = Residential Property Price
GDP = Real Gross Domestic Product
INF = Inflation Rate
INT = Interest Rate
INV = Investment
e = Error

ANALYSIS AND DISCUSSION

The research started by regressing the four variables, interest rate (INT), inflation rate (INF), Growth Domestic Product (GDP), and investment (INV), against the residential property price (HPI) using the Ordinary Least Square method of regression. The study uses Eviews software as the statistical analysis tool; the result is shown in Figure 7.

Dependent Variable: HPI
Method: Least Squares
Date: 07/26/21 Time: 23:12
Sample: 1990 2020
Included observations: 31

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-22.97661	11.02026	-2.084942	0.0470
GDP	5.24E-10	5.92E-11	8.849819	0.0000
INF	1.228766	1.808890	0.679293	0.5030
INT	1.490180	0.631589	2.359413	0.0261
INV	1.74E-11	2.02E-10	0.085824	0.9323

R-squared	0.957672	Mean dependent var	101.6552
Adjusted R-squared	0.951159	S.D. dependent var	49.34022
S.E. of regression	10.90413	Akaike info criterion	7.762851
Sum squared resid	3091.404	Schwarz criterion	7.994139
Log likelihood	-115.3242	Hannan-Quinn criter.	7.838245
F-statistic	147.0610	Durbin-Watson stat	0.555560
Prob(F-statistic)	0.000000		

Figure 7: Result of regression

Symbol	Description	Measure/Proxy
HPI	Residential Property Price	Housing price index in constant 2010
GDP	Gross Domestic Product	Real GDP in constant 2010 based price
INF	Inflation rate	Inflation, consumer prices (annual %)
INT	Interest rate	Real interest rate (%)
INV	Investment	Capital investment @ Gross capital formation (current US$) (formerly gross domestic investment)

The equation is as follows:

HPI = -22.9767 + 5.24E-10GDP + 1.2288INF + 1.4902INT + 1.74E-11INV.

Based on the results, the goodness of fit (R^2=0.9577) shows that the variables have a significant positive relationship with the housing price. Furthermore, it shows that 95.77% of the variation of INT, INV, INF, and GDP is explained by the variation of HPI. Overall statistical testing is determined using the calculated F-statistic, 147.0610. This interpretation supports that the regression is significant because the probability of F-statistic, 0.0000, is statistically significant at 10%, 5%, or 1%. The mean is 101.6552. Moreover, the Durbin-Watson statistic is 0.5556 and falls under positive serial correlation.

Also, by referring to the above results, taking a 1% level of significance, the independent variables of GDP (β_1=5.24(10)^$^{-10}$, t-statistic = 8.8498, p=0.0000<0.01) significantly and positively affect the residential property price. As a result, it shows a positive relationship between this variable and residential property price. Also, it supports other researchers' findings, like Zandi et al. (2015) and Akumu (2014); they mentioned that the GDP positively affects the residential property price in Malaysia.

Furthermore, the independent variables of INF (β_2=1.2288, t-statistic = 0.0858, p=0.5030>0.10) do not significantly affect the residential property price. By comparing the p-value, it shows that p=0.5030>0.10. This result aligns with San Ong (2013), who indicated that INF is not statistically significant with residential property prices.

On the other hand, the independent variables of INT (β_3=1.4902, t-statistic = 2.3594, p=0.0261<0.05) significantly and positively affect the residential property price. As a result, it shows a positive relationship between this variable and residential property price. Also, it supports other researchers' views, like Zandi et al. (2015) and Akumu, D. O. (2014), that INT positively affects the residential property price in Malaysia.

Last, the independent variables of INV (β_4=1.74(10) ^^{11}, t-statistic = 2.3594, p=0.932 (p=0.932>0.10) do not significantly affects the residential property price. By comparing the p-value, it shows that p=0.5030>0.10. This finding is consistent with Abdul Latif et al. (2020), who said that the relationship was viewed broadly.

Now by referring to the probability value of each variable, both p-values of variables INF=0.5030 and INV=0.9323 are not statistically significant at a 5% or 10% significance level. Thus, H2 and H4 are rejected at a 5% or 10% significance level. Therefore, investment (INV) and inflation (INF) positively influence the residential property price but are statistically insignificant. In contrast with the Growth Domestic Product (GDP) and interest rate (INT) variables, both are statistically significant at 1% and 5%, with the probability value of GDP=0.0000 and INT=0.0261. Thus, H1 and H3 are accepted and statistically significant. Therefore, investment (INV) and inflation (INF) positively influence the residential property price and significantly affect the residential property price statistically.

CONCLUSION

In conclusion, this study aims to analyse the influence of inflation, investment, interest rate, and GDP on the residential price in Malaysia before and during COVID-19. This study used annual time series data covering the period from 1991 to 2020. Multiple regression model techniques are conducted to meet the purpose of the study.

As reported in the previous section, the findings based on multiple regression modelling approaches show that GDP and interest rate only have a positive relationship and a statistically significant impact on residential property prices in Malaysia. However, investment and inflation positively influence the residential property price but are statistically insignificant.

In contrast with the growth domestic product and interest rate variables, both are statistically significant at 1% and 5%. These findings are consistent with the research conducted by (Zandi et al., 2015), which indicated that the inflation rate is not a significant variable of the residential property price.

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THE ELDERLY QUALITY OF LIFE (E-QoL) AND RETIREMENT VILLAGE PREFERRED FEATURES BY MALAYSIAN GENERATIONS

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Abstract

Along with the continuous growth of the elderly population, Malaysia projected to become an ageing nation by 2030. The Retirement Villages are a Restricted Ageing Community that offers a complete range of services supplying the diverse housing demand of the elderly (seniors) generation. The World Health Organization (WHO) identified four broad domains universally relevant to the Quality of Life: physical and psychological health, social relationships, and environment. This study aims to provide an in-depth overview of the Retirement Villages in Malaysia. The objectives of this study are sets as follows: (i) To define the Elderly Quality of Life (QoL), and (ii) To determine the generational preferences features of Retirement Village in Malaysia. The Malaysian housing generations involved in this study are the Baby Boomers, Generation X (Gen-X), Generation Y (Gen-Y), and Generation Z (Gen-Z). With a mixed-methods approach, the derived findings revealed that preferred generational features of Retirement Villages are diverse for each main feature; (i) Location; (ii) Services; (iii) Design Criteria; (iv) Physical Environment; and (v) Social Activities. This study contributes more understanding of the main actors of property development and the real estate industry players on the preferred features for Retirement Villages in the Malaysian context.

Keywords: Elderly (Seniors), Quality of Life (QoL), Age-Restricted Community, Retirement Village

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INTRODUCTION

As individuals age, housing expectations become more associated with health and care concerns. Among the houses related to the elderly is a non-assisted or independent living, assisted living and nursing homes (Tan & Lee, 2018). For seniors, various housing options are already accessible, varying from independent living to high-level care. Retirement villages are one of the options for an independent retirement lifestyle, providing the resident with comfort and flexibility in various ways (Hassan & Jiaqi, 2017). Retirement villages are multi-unit living communities that provide a variety of health, recreational, and support services to persons aged 65 and above (Sritharan et al., 2019). Elderly folks seeking a better lifestyle in the future will find a retirement village to be the ideal elderly housing option.

In Malaysia, just a few research have investigated the preferred attributes of Malaysian seniors housing (Ismail et al., 2020). To guarantee that the elderly's Quality of life is improved, the awareness of the need for proper retirement homes in Malaysia needs to be improved (Lim et al., 2019).

LITERATURE REVIEWS

The Generations and Elderly Generations Defined

Tung & Comeau (2014) described the generation as a group born within a specific time frame. Generations are defined as people born at the same time or gap, periods wherein economic and social movements occurred (Çelik & Gürcüoğlu, 2016). Table 1 shows different terms or names used to represent the generations according to each cohort group. Each generation may have a distinct personality and behaviour that will affect their needs and preferences. Every generation is influenced by their generational characteristics, beliefs, experiences, lifestyles, ideals, and demographic background. Each generation's timeframe has a significant impact on the next, and temporal gaps between them which increase disparities significantly (Çelik & Gürcüoğlu, 2016).

In addition, the definition of elderly, also known as senior citizens, varied across the literature. In Western countries, the beginning of old age correlates to retirement age ranging from 60 to 65 (World Health Organization, 2019). According to Jumadi et al. (2019), 60 years of age and above have been widely accepted as the start of the elder years, though definitions vary by country, community, and period. Morrison (2016) defined older people in a few terms, such as the caregivers, the aspirational downsizers, the older couple, and the typical adults aged 60-75 who might not employ, value their leisure time, and want to spend on themselves. The elderly, otherwise known as the Baby Boomers generation for those that, were born between 1946 and 1961 (Ismail et al., 2020). In the Malaysian context, the term elderly refers to people 60 years old and above following the Malaysian retirement age (Ismail et al., 2019). Yassin et al. (2018) describe retirement as when a person quits a career or paid job and starts to live off their pension. Three necessities for retirees are finance, housing, and healthcare (Yassin et al., 2018). Retirement is a state of being or a relatively steady point in life.

Table 1: The Generations Classifications

Author	Generation Name	Generation Classification Years
Conisbee & Reed (2006); Ismail et al., (2019)	Baby Boomers, Baby Boom, Boomers, Traditional generations, Post-war generations, Me Generations, Baboo, Love Generation, Woodstock Generation and Sandwich Generation	1946-1961
Ismail et al.,(2019); Conisbee & Reed (2006); Tung & Comeau (2014)	Generation X (Gen-X), Gen Xers, 2nd Boomers, Baby Bust, Slackers, Thirteenth Generation, Why me Generations, The Latchkey Generation, Communist Generations.	1962-1976
Ismail et al., (2019); Conisbee & Reed (2006);	Generation Y (Gen-Y), Millennials, Echo Boomers, Why Generation, Net Generation, Democracy generation, Gen Wired, We Generation, DotNet, Ne(x)t Generation, Nexters, First Globals, iPod Generation, and iYGeneration.	1977-1991
Ismail et al., (2019); Conisbee & Reed (2006);	Generation Z (Gen-Z), Post Millennials, 0 Generation, Digital Natives, Me Generation, Generation and Generation 2020	1992-2012

The Elderly (Senior) and Housing

There has been an increase in worldwide studies on various topics concerning seniors and housing (Mulliner et al., 2020). According to Yassin et al. (2018), housing for the elderly was described as a place where the elderly can be protected, as well as the amount of care given within that location. Folks can safely stay in their dwellings as they age as long as they have the appropriate supportive services (Iecovich, 2014). Many elderly desire to age in place in their homes as long as they can (Chan, 2017). When individuals get older, they have less intention and are more hesitant to consider migrating (Hui et al., 2014). Other research in the Netherlands (Jong et al., 2012), Hong Kong (Hui et al., 2014), Sweden (Abramsson & Andersson, 2016), and Ireland (Fox et al., 2017) shows that elderly people have a strong desire to age in place. However, Ismail et al. (2019) argue that although the elderly generations have shown the desire to age in place and live independently, there will come to a point when they have no option but to rely on others. As a result, the elderly may have no choice but to move and live with their family members or move to other options of senior housing.

According to Aini et al. (2016), the typical housing alternatives for the older population may be grouped into four categories: family home (ageing in place), elderly care, medical institution, and retirement community. Independent Living, Assisted Living, and Nursing Homes are the most popular forms of senior housing for seniors in the Western (Tan & Lee, 2018). Some researchers explain that various housing options are available, varying from independent living to total care packages. Yassin et al. (2018) mentioned that retired people can now live-in retirement villages instead of their own or older people's homes. Specialised housing for the elderly provides varying levels of assistance and care (Ball & Nanda, 2013). According to the housing demand and late-life mobility theories, elders would choose the home that best meets and suits their needs (Gibler & Clements, 2011). World Health Organization (2019) has outlined the framework for senior-friendly housing, which consists of a few elements: affordability, community connection, access to services, safety and security, essential services, design and many more.

Mulliner et al. (2020) mentioned that elder-friendly housing should be built with ageing-in-place criteria. Several studies in several nations have discovered a trend toward smaller dwellings and apartment living as people get older (Andersson et al., 2019). Elders prefer a home without stairs (Abramsson & Andersson, 2016; Chen, 2017). Jong et al. (2012) reveal that in the Netherlands, the younger generation of retired people favoured detached residences. The residential attributes of the elderly are commonly connected to their safety and social cohesion (Ossokina et al*.,* 2018). According to Chen (2017), detailed considerations for seniors' housing architecture include privacy, social interaction, clear direction, security and comfort. The elderly will feel safe and secure by living in an area with good security, providing indoor parking or generally a smaller building to live in (Ossokina et al., 2018).

The Retirement Village

Retirement villages are complexes, including residential premises mainly designed to be occupied by retirees engaged in village agreements Counsel (2014). A retirement village is a type of multi-residence dwelling, mainly consisting of communities of individual accommodation for older people or for people aged 55 and above who may have retired from their jobs (Osei-Kyei et al., 2020). Even though the terminology used to define retirement villages varies across the country, a retirement village may usually be described as a senior-centred community which offers various services and amenities (Peri et al., 2020). Generally, a retirement village is a housing community for elders who are typically capable of caring for themselves (Hassan & Jiaqi, 2017). In addition, Malaysia offers simplified types of retirement village concepts known as the 'Pondok' system (Aini et al., 2016), emphasising religious programmes and activities (Ibrahim et al., 2012).

A retirement village must be able to fulfil the demands of the increasing amount of senior citizens (Ejau et al., 2021). Retirement villages are, therefore, more than just an older communities; they are also places where the elderly and younger generations may connect socially (Bernard et al., 2012). This idea has been designed to provide the elderly with a well-maintained, new and healthy setting, as Ng et al. (2020) mentioned. The higher-end consumer market typically targets retirement villages. Ball & Nanda (2013) mentioned that some wealthier elderly would alter their current private homes and hire personnel to fit their needs. However, this personalised alternative is not recognised as a specialised dwelling. Table 2 shows some definitions of Retirement Village.

Table 2: Retirement Village Definition

Definition	Keywords	Authors
Retirement village comprises “a residential environment that is specifically designed to provide older people with accommodation, services and facilities to meet their requirements”	● Older people ● Accommodation, Services and Facilities	(Hu et al., 2018)
A retirement village is " an age-segregated community that provides diverse services and facilities to meet the residents' unique needs in later life."	● Age-segregated community. ● Diverse services and facilities ● Meet needs in later life	(Hu et al., 2019)
Retirement villages and communities are defined as "structured, low-density, age-segregated developments built with private funds that provide comprehensive recreational facilities and generally low-cost housing for the senior."	● They are structured, low-density, age-segregated development. ● It was built with a private fund. ● Recreational facilities	(Hassan & Jiaqi, 2017)

A retirement village can offer several benefits to the resident (Yeung et al., 2017). Independent living has long been seen as a necessary component of good health (Ball & Nanda, 2013) which can be experienced in the retirement village as described by Yassin et al. (2018). Furthermore, a retirement village's amenities and social activities allow older people to connect and mingle with other residents (Yassin et al., 2018). Social relationships can assist the elderly in achieving happiness, a healthier life, and long life (Shah et al., 2021). Being in retirement villages could also minimise loneliness, enhance wellness, and enable elderly adults to age in place with confidence, according to a recent study in the United States (Graham et al., 2014). The facilities and amenities within walking distance in the retirement village promote ageing in place (Jolanki, 2021). Various services like transportation, meal delivery and medical treatment are also benefits of retirement villages (Siegler et al., 2015). Living in retirement villages has been shown to have a positive influence on improving individuality, well-being, standard of living and social connectivity and positive satisfaction with the living arrangement (Yeung et al., 2017)

The Elderly Quality of Life (E-QoL) Concept

The World Health Organization explain the Quality of life as a person's assessment of their place in life in line with objectives, goals and concerns. Following that, the established idea of health-related Quality of Life is described as how an individual performs in their life and also their overall wellness in physical, mental, and social (Köves et al., 2017). Cai et al. (2021) mentioned four components of the health dimension Quality of life are physical, mental, social, and functional health. Ferreira et al. (2018) describe the Quality of life of elders as a broad notion that encompasses not just physical health but also psychological well-being, independence, socialisation, personal views, and other aspects of an individual's lifestyle, such as goals, expectations, standards, and concerns. Numerous challenging conditions like changes in health condition, dealing with new constraints and new responsibilities are connected with older age effect on Quality of life. Seraji et al. (2017) also revealed that variables such as loss in cognitive compatibility and a decline in self-reliance might influence the Quality of life of senior people. Some prevalent factors used in measuring the Quality of life of the elderly are economic stability, privacy, physical health and more (Cantarero & Potter, 2014).

RESEARCH METHODOLOGY

The locality area of Johor Bahru City Council has been chosen as the case study. Johor Bahru City Council is one of the local authorities in the state of Johor, Malaysia. The Johor Bahru City Council governs the city of Johor Bahru and other parts of the Iskandar Malaysia region. The Johor Bahru City Council covers an area of 220 km². Based on the data from the Johor Bahru City Council, the total number of populations in the administration of Johor Bahru City Council are approximately 797,882 as of 2017.

This study employs a mixed-method research strategy. Combining both data in a convergent design will allow a researcher to acquire a strong understanding of the one provided by the quantitative or qualitative results (Dawadi et al., 2021). Furthermore, the employment of mixed methods in each study gives a more profound knowledge of research challenges than one alone (Ismail et al., 2020). Thus, research which adopts both approaches with a combination of qualitative and quantitative data gathering will eventually create robust research outcomes. For this research, five (5) property players as experts were interviewed (5th November 2021 until 3rd December 2021 to get their overview on the current Retirement Village preferences features. Convenient sampling has been chosen for the quantitative part of this study. The survey questionnaires were distributed through GoogleForm to the targeted population from 17th November 2021 to 10th December 2021). One hundred sixty-one (161) collected survey questionnaire responses were further analysed using the software SPSS (version 26). Next, the quantitative variables were calculated with inferences from the significant population sample.

MAIN FINDINGS AND DISCUSSIONS

The Retirement Village Preferred Features by Generations in Malaysia

Table 1 shows the summarised details of the respondents for this study. The gained responses comprised males (44.1 per cent) and females (55.9 percent). By generations; Baby Boomers Generation (19.3 percent); Generation X (19.3 percent); Generation Y (21.7 per cent); and Generation Z (39.8 per cent). Many of the respondents were employed (53.4 per cent), followed by unemployed (21.1 per cent), and the remaining were unemployed and retirees (25.5 per cent). Most of the respondents were married (54.7 per cent), and the remaining were single (45.3 per cent).

Table 1: Demographic Background of the Respondents

Characteristic	Details	Number of Respondents	Percentage (%)
Gender	Male	71	44.1
	Female	90	55.9
Generations	Baby Boomer	31	19.3
	Generation X	31	19.3
	Generation Y	35	21.7
	Generation Z	64	39.8
Occupation	Employed	86	53.4
	Unemployed	34	21.1
	Retired	41	25.5
Marital Status	Single	73	45.3
	Married	88	54.7
	Others	0	0
Ethnicity	Malay	101	63.0
	Chinese	37	23.0
	Indian	22	14.0
	Other (Iban)	1	1.0
Income Level	Below RM1,500	50	31.1
	RM1,501-	41	25.5
	RM5,000	54	33.5
	RM5,001-	16	9.9
	RM10,000		
	Above RM10,000		
Health Status	Excellent	56	34.8
	Good	66	41.0
	Fair	37	23.0
	Poor	2	1.2

Next, by ethnicity; Malay (63 percent); Chinese (23 per cent); Indian (14 per cent); and Others (Iban) (1 percent). Finally, by income groups, most of the respondents (33.5 per cent) had an income level of between RM5,001-RM10,000, followed by an income level below RM1,500 (31.1 per cent). Next is the respondents' income level; the income level is between RM1,501-RM5,000 (25.5 per cent) and the income level group above RM10,000 (9.9 per cent). Lastly, the respondents were also asked to rate their health status. Most respondents have excellent health conditions (34.8 per cent), followed by good health conditions (41.8 per cent). While the other 23 per cent of the respondents have fair health conditions, and only 1.2 per cent have poor health conditions.

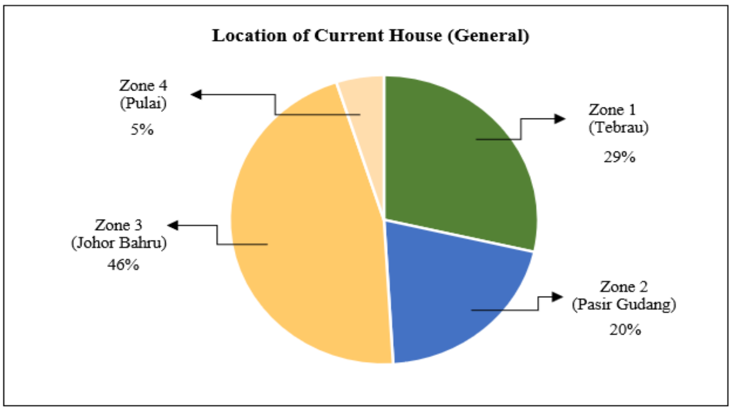

Figure 1: Location of Current House (Overall)

Location of Current House by Generation (Detail)								
Generations	**Baby Boomer**		**Generation X**		**Generation Y**		**Generation Z**	
Location	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**
Zone 1 (Tebrau)	6	13.0	8	17.4	9	19.6	23	50
Zone 2 (Pasir Gudang)	9	27.3	7	21.2	11	33.3	6	18.2
Zone 3 (Johor Bahru)	12	16.2	15	20.3	13	17.6	34	45.9
Zone 4 (Pulai)	4	50.0	1	12.5	2	45.9	1	12.5
Total	31	19.3	31	19.3	35	21.7	64	39.8

Figure 2: Location of Current House by Generations

As illustrated above (Figure 1), the results show that most respondents live in Zone 3 – Johor Bahru (46 per cent). The respondents' location is followed by Zone 2 – Pasir Gudang (20 per cent) and Zone 1 – Tebrau (29 per cent). Finally, the least respondents live in Zone 4 – Pulai (5 per cent).

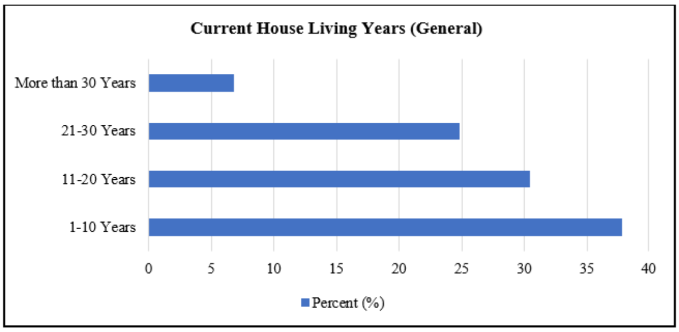

Figure 3: Current Housing Location (Years) (Overall)

Next, for the current house years of living, 37.9% (61) respondents currently live in their house for a duration of 1-10 Years, followed by 30.4% (49) respondents who lived in the house between 11-20 Years. 24.8% (40) of respondents have lived in their house for 21-30 Years. Meanwhile, only 6.8% (11) of respondents lived in their current house for more than 30 years.

Current House Living Years by Generations (Detail)								
Generations	**Baby Boomer**		**Generation X**		**Generation Y**		**Generation Z**	
Years	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**
1-10 Years	3	4.9	1	1.6	28	45.9	29	47.5
11-20 Years	18	36.7	5	10.2	5	10.2	21	42.9
21-30 Years	9	22.5	16	40.0	2	5.0	13	32.5
More than 30 Years	1	9.1	9	81.8	0	0	1	9.1
Total	31	19.3	31	19.3	35	21.7	64	39.8

Figure 5: Current Housing Location (Years) by Generations

Table 2 shows the Retirement Village preferred features by Malaysian generations. For the Location Factors, the features of nearness to family, friends, and social networks were Ranked-1 by both Baby Boomers and Gen-X, Ranked-2 by Gen-Y and Ranked-3 by Gen-Z. Nearness to social meeting spots and leisure centres was also regarded as the most important locational preference; Ranked-1 (Gen-X and Gen-Y) and Ranked-2 (Baby Boomers). This finding shows that most generations prefer to live independently during retirement and are willing to consider residing in Retirement Village. However, the location of the Retirement Village must be near family and friends to able them to still have close contacts to be visited at any time or at least near social community centres for continuity of social engagements. This finding shows signs of Active-Ageing among the elderly or during elderly age. Next, the locational features of accessibility to health care centres/health services were Ranked-2 by both older generations (Baby Boomers and Gen-X).

In contrast, the feature was Ranked-1 by Gen-Y and Gen-Z younger generations. The contrast of preferences shows that the younger generations regard accessibility to medical services as the main priority feature for a Retirement Village. This finding shows that the younger generations are willing to live in Retirement Village not near the nearby family and friends. Thus, emergency service availability is most important compared to social aspects. Interestingly, the locational features regarding accessibility to local amenities were believed to be necessary to three generations, Ranked-2 by Gen Z and Ranked-3 by both the older generation (Baby Boomers) and the younger generation (Gen-Y). This finding shows that amenities are one of the most critical preferred features of housing location, including for a Retirement Village. Nearness to public transportation was Ranked-4 by the Baby Boomers, Gen-X and Gen-Z. This finding is because most of the Retirement Village will provide scheduled services of in-house transportation charter for the occupants of the Retirement Village.

As for the services factor, all three service preferences features, access to various services and amenities, healthcare services and support services, were regarded as most important by Baby Boomers (Ranked-1 Retirement Village. This feature is significant for the elderly to relocate to a Retirement Village Gen-X and Gen-Y are both Ranked-1 support services features and are accessible to varieties of services and amenities as Ranked-2.

For the design criteria preferences features, the elderly and user-friendly design were perceived as the most critical features (Ranked-1 and Ranked 2) by all generations (Baby Boomers, Gen-X, GenY and Gen-Z). A good Retirement Village should be equipped with elderly-friendly design features in the buildings and surroundings to able the elderly generation occupants to be having good Quality of life. This feature is also vital, including for each non-assisted Retirement Village. Developing senior-friendly surroundings which facilitate mobility and participation in fundamental activities might help elders to age in place even more (World Health Organization, 2019).

As for the physical environment preferences factor, green spaces allocation (Ranked-1 by Baby Boomers and Ranked-2 by Gen-X), Quality environmental conditions and layout orientation features were both Ranked-2 by Baby Boomers and Ranked-1 by Gen-X. These vital features show that the generation considers all three physical environment features; green space allocation, environmental conditions and layout orientation are crucial for a Retirement Village. Furthermore, the need for these physical environment preferred features shows that the elderly and the younger generations (Gen-X, Gen-Y and Gen-Z) appreciate the Quality of life (QoL), which emphasises physical, psychological and environmental features should be available in each Retirement Village.

Table 2: The Retirement Village Preferred Features by Malaysian Generations

Generations	Baby Boomer			Generation X			Generation Y			Generation Z		
Preferences Factors/Features	**Mean**	**Standard Deviation**	**Rank**	**Mean**	**Standard Deviation**	**Rank**	**Mean**	**Standard Deviation**	**Rank**	**Mean**	**Standard Deviation**	**Rank**
Location												
Near to family, friends, and social networks	3.94	0.250	1	3.68	0.475	1	3.89	0.323	2	3.45	0.733	3
Accessible to local amenities	3.77	0.425	3	3.39	0.558	4	3.80	0.406	3	3.64	0.601	2
Accessibility to health care center or health services	3.87	0.499	2	3.58	0.502	2	3.91	0.284	1	3.73	0.512	1
Near to public transportations	3.71	0.588	4	3.48	0.626	4	3.89	0.323	2	3.08	0.948	4
Near social meeting spots and leisure centers	3.87	0.499	2	3.68	0.475	1	3.91	0.284	1	3.11	0.857	5
Services												
Accessible to varieties of services and amenities	3.84	0.523	1	3.74	0.445	2	3.91	0.284	2	3.45	0.733	3
Healthcare Services	3.84	0.523	1	3.19	0.534	3	3.94	0.236	2	3.77	0.527	1
Support Services	3.84	0.523	1	3.81	0.402	1	3.91	0.284	2	3.59	0.555	2
Design Criteria												
Elderly and user-friendly design	3.90	0.301	1	3.61	0.558	1	3.89	0.404	2	3.64	0.627	2
Ageing in place criteria	3.84	0.374	3	3.32	0.475	3	3.80	0.473	3	3.50	0.690	3
Safety and Security Features	3.87	0.499	2	3.58	0.502	2	3.94	0.338	1	3.77	0.463	1
Physical Environment												
Quality Environmental Conditions	3.77	0.560	2	3.58	0.502	1	3.91	0.284	1	3.48	0.690	1
Green Spaces Allocation	3.81	0.534	1	3.42	0.502	2	3.83	0.382	2	3.47	0.712	2
Layout Orientation	3.77	0.560	2	3.58	0.502	1	3.80	0.406	3	3.33	0.736	3

CONCLUSIONS AND RECOMMENDATIONS

The findings from the study reveal four (4) main features for a Retirement Village in the Malaysian context; (1) Location; (2) Services; (3) Design Criteria; and (4) Physical Environment Preferred Features. The preferred Retirement Village Features derived from the study show signs of the willingness of the Malaysian Elderly and the generations to the idea of Retirement Village as an example of an Age-Restricted Concept in the promotion of Active and Healthy Ageing. The Retirement Village concept is widely accepted overseas as it is perceived as the best option for the elderly to age in place independently yet still be valid to the community. In addition, the elderly-friendly housing design features and the social engagement features such as social activities and green physical environment surroundings embedded in the Retirement Village may assist in the idea of active ageing among the elderly.

This study focuses on Retirement Village features without considering specific features preferred by different religions or gender. Therefore, for future studies, a similar study on Retirement Housing in Malaysia is recommended to focus on the Quality of Life (QoL) of an Islamic Retirement Village. Including the Islamic Retirement Village preferred features is crucial for improving the 'Pondok' system as one of the available options for Age-Restricted Housing for the Muslim elderly in Malaysia.

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THE FORMULATION OF SUSTAINABLE AND HIGHEST BEST-USE (SHBU) MODEL FOR FELDA LANDUSE DEVELOPMENT

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Abstract

FELDA land development focuses on settlements and agricultural areas, hence it is crucial for them to be managed efficiently. This study aims to establish a model that integrates sustainable land development with high income returns from the land. Therefore, this study identifies the elements essential for sustainable and highest best-use (SHBU). Several research approaches have been conducted namely Focus Group Discussion, documents analysis and questionnaire survey in order to search for key elements to be adapted into the SHBU model. From the analysis, five elements of the Sustainability and Highest-Best Use (SHBU) model, are discovered that they comprise of FELDA industries-based crops (FIbC) and SHBU, Strategic plan management (SPM), FELDA business centre (FBC), FELDA residential compound (FRC) and FELDA agro-preneur (FagP). These five-dimension SHBU model serves as a tool to assess the case study of FELDA settlement in order to come up with strategies to solve land development issues.

Keyword: Sustainability, Highest Best-Use, FELDA, Land development

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INTRODUCTION

Malaysia has an abundance of agricultural land, particularly the FELDA lands, which have the potentials for a higher return in modern agricultural, industry and business sectors. With vast agricultural lands, FELDA can be the leader in large-scale food industries either for local consumers consumption or the products could be exported. For this to take place, FELDA needs to play a key role in promoting and generating various rural economic activities to close the gap between urban and rural areas (FELDA, 2019), and to uplift FELDA itself towards sustainability and resilient settlement schemes. Presently, there is a substantial number of FELDA households that remain in the lower income bracket. This may be caused by multiplicative factors of unproductive crop activities, commodity's market volatility, lack of reform strategies, high debt, and many other related issues as mentioned by the Minister in the Prime Minister's Department (Economy) Datuk Seri Mustapa Mohamed in his speech on FELDA recovery plan, as recorded in The Sun Daily (2021). Due to these circumstances, there is a need to find interventions and solutions to such issues especially since FELDA lands have the potential to be part of the highest and best use of land with a higher return to enhance the quality of life and livability of its settlers and the nation, in general.

LITERATURE REVIEW

FELDA, by itself, has introduced a blueprint, the so-called report of *Kertas Putih*, which enforces a new direction of sustainable FELDA development in the future (FELDA, 2019). Through the *Kertas Putih*, two main catalyst projects were introduced: (i) the Settlers Development Programme (*Program Pembangunan Peneroka - PPP*) with the aim to generate additional income to settlers and support the national food security initiative; and (ii) Smart farming initiative via the Smart Plantation Management System (SPMS). The implementation of both is still at a pilot stage and this opens a venue for intervention (Rashid M.F.A, et.al, 2021). In short, PPP and SPMS are two catalyst initiatives in *Kertas Putih*, with the main goal of revitalising FELDA into a new chapter of transformation in terms of their fundamental issues, and prospects. Both are very significant initiatives to ensure the sustainability of FELDA as a national rural catalyst development to improve the livelihoods and prosperity of settlers and their new generation (FELDA, 2019).

Through PPP, it is estimated that each participant of this programme will get an additional monthly income ranging from RM500.00 to RM1000.00. PPP is going to focus on cash crops (such as MD2 pineapple, fertigation chilies, young ginger, etc.), aquaculture, and livestock on the identified areas or spaces at the settlers' housing lots or vacant lots in FELDA settlement areas. These projects are granted based on several criteria such as the preference of the participants, expected high additional income from the participants, minimal usage of land area, and technical expertise of FELDA. The project will be awarded to the participants in terms of a grant worth a maximum of RM10,000.00 or more for Plasma Category, and RM20,000.00 or more per participant for Cooperation Category. Currently, there are 3202 approved projects worth RM58.3 million (Rashid M.F.A, et.al, 2021).

Meanwhile, SPMS is a crop smart management system developed by FELDA Research and Development Department (R&D) that is based on Geospatial Information System (eGIS) to manage and monitor the palm oil estate efficiently. Currently, there are 26 FELDA settlement schemes throughout Malaysia that have been monitored by the SPMS application which is still in Phase 1. SPMS uses drone technology and satellite images for high-resolution images to screen and measure the performance of palm oil trees for monitoring and cost-efficiency purposes. Therefore, based on the discussion above, a gap is found. This gap needs to be closed to cater the shortfalls in both projects, especially on land selection decision making, high-crop scenario planning, measurement, and supportive intervention strategy formulation. The PPP, for example, is currently only implemented on a basis of settlers' preferences on their own spaces without land allocation or suitability land analysis for the entire settlement scheme. Furthermore, a comprehensive planning of physical-support systems such as a business centre, crops collection hub, and so on, is required. Moreover, SPMS is undoubtedly an outstanding system that enhances the management of estates and crops. However, FELDA is still in a dire need of a comprehensive support to ensure sustainability and the highest-best use for cropland development (Rashid, M.F.S, 2021). With this, the study shall fulfil the gap through the exploration of the FELDA land development framework.

RESEARCH AIM AND OBJECTIVES

This study is aimed at formulating a model for developing FELDA land with sustainability while ensuring the highest and best-use of the land. This aim shall be achieved through the following objectives:

i. To identify the sustainability and highest-best use (SHBU) elements that incorporate them with the national policy inspirations.
ii. To understand the needs and opinions from the relevant stakeholders regarding the SHBU elements for better land development
iii. To propose suitable conceptual domains and the strategies that strengthened the FELDA land development.

RESEARCH METHODOLOGY

This study conducts qualitative research that consists of three main research approaches. First is document analysis that focuses on the concepts and approaches of sustainable and contemporary land development and best practices of the highest-best use relevant to FELDA transformation. Moreover, the contents analysis involves three identified reports or documents, namely Dasar Perancangan Fizikal (PDF), Desa Negara (2017), Dasar Pembangunan Luar Bandar (DPLB) (2018) and FELDA's Kertas Putih (2019).

The second approach is based on two (2) focus group discussions (FGD) sessions. This processes help build a conceptual understanding of FELDA lands development based on real issues and problems faced by FELDA settlers and FELDA management in settlement areas. Discussion with this focus group revolves around potentials and suggestions in improving the land development and income generations of the settler. The first FGD was conducted on 29 June 2021 via an online Google Meet, and the subjects were represented by eight (8) participants. The focus group is made of four first-generation FELDA settlers, three from second FELDA generations and head of division official from FELDA branched and headquarters. Then, seconf FGD session was with FELDA Representatives: (a) FELDA Lands Management Office and head of Program Pembangunan Peneroka, and (b) eGIS and RnD departments. The special sessions were conducted on 28 July 2021 and 24 August 2021, respectively, via online Google Meet. The FGD and special sessions were conducted to obtain first-hand information and fundamental issues regarding FELDA development and their feedback on the proposed framework. All related information was then transformed into themes and interpreted accordingly to validate the formulation of the SHBU framework.

The third method of data collections involved questionnaire survey that was conducted for two weeks starting from 12th July 2021 until 18th July 2021 via Google Form. The survey was aimed to obtain the perspectives or views of the FELDA generations regarding the best future development of the FELDA lands and potential economic activities, as well as to obtain an overall picture of demographic and socioeconomics of the respondents. Moreover, it is also a process to triangulate the significance of the SHBU framework to cater to the current states or desires of the FELDA's generations. The respondents of the survey were open to all generations that are willing to participate. Overall, 39 respondents were involved in the survey.

ANALYSIS AND DISCUSSION

Summary From the Document Analysis.

The analysis discussed the integration on sustainable element and Highest best-use. Rural Development Policy acts as a guidance in developing the rural area until 2030. This policy was crafted based on three principles (Kementerian Pembangunan Luar Bandar, 2018) that are stated below:

1. **Sustainability** - which gives priority to quality and sustainable community life.	2. **Inclusive** - which considers balance development in all aspects of life.	3. **Holistic** - which encompasses various dimensions such as social, economic, spiritual, physical, culture and governance.

Basically, Table 1 shows the Rural Development Policy has 10 pillars that will become the basis of the SHBU Model. Generally, all pillars of Rural Development Policy are related to the scope of this research, except the 8th pillar - regarding Effective Delivery and Governance Systems. This situation shows that the scope of this research is parallel with Rural Development Policy.

Table 1: Relationship of Pillars of Rural Development Policy and Scope of Research

No.	Pillars	Element Adopted to FELDA Land Development, SHBU Model
1	Competitive and sustainable economy.	Cash Crop, Agricultural Projects
2	Entrepreneurship driven economic development.	Agropreneurship
3	Quality human capital.	Agropreneurship
4	Complete and modern infrastructure.	Business Centre, Residential Settlement
5	Excellent rural young generation.	Agropreneurship
6	Progressive rural women.	Agropreneurship
7	Sustainable rural life.	Residential, community
8	Effective delivery and governance systems.	Sustainable Plant Management
9	Biodiversity and sustainable environment.	Cash Crop, Agriculture
10	Housing, regional development and integrated rural settlement.	Residential

Source: Adopted from Kementerian Pembangunan Luar Bandar (2018)

Meanwhile for HBU, according to The Appraisal Institute, (2001), HBU is defined as the possible legal and logical use of an empty or upgraded property, which physically, reasonably, and financially feasible, allowing it to deliver the highest value (Utomo et al., 2018)

1. Legal Acceptance Analysis
a. (private restriction, zoning, building codes, and environmental regulation)
2. Physically possible
a. (size, shape, terrain, and the availability and capacity of public facilities)
3. Financial acceptance
a. (cost of land preparation, construction costs (building costs and fixed equipment costs), professional service fees, administration fees, and other costs)
4. Maximum productivity analysis
a. (value of land was determined based on gross development value, total development value, and minimum profit requirements)

Meanwhile, the term sustainable development is the idea that human societies must live and meet their needs without compromising the ability of future generations to meet their own needs. According to Walacik et al. (2020), the concept of sustainable development involves much more than the "green" issue. "Sustainable value" can reflect not only economic issues (reflected directly by property value) but can exceed its meaning to a broader sense, including sustainable development issues (social, political, environmental directions) at the same level. It thus can create an added value for real estate analysis (mainly based on "highest and best use" assumptions). Even though the "highest and best use" notion has been defined, its interpretation causes many ambiguities and problems. "Highest value" is a condition that requires consideration of all the circumstances (physical, legal, financial and productivity) with maximum: return rate/developed area/increase of build-up area. Maximal productivity in the highest and best use context means it does not directly cause any decreases in sustainable value or/and give the possibility to increase the sustainable value in the future.

Findings of Focus Group Discussion (FGD) with FELDA

The FGD was conducted on 29th June 2021 via an online Google Meet. It is aimed to obtain the opinion and perspectives of the FELDA representatives to respond to the research direction and the proposed framework of FELDA lands development based-SHBU, and other related fundamental issues to be discovered in the research. Eight participants holding various positions affiliated with FELDA attended the session. There were four first-generation FELDA settlers, 3 from second FELDA generations and a head of division official from FELDA headquarters.

The following are the summary of the comments, opinions and findings (based on dimensions and fundamental issues of the FELDA settlement), but not limited to:

i. ***Element 1: FELDA Crops & Future Prospects***

- Under current practices, FELDA crop land is only used for rubber and palm oil commodities. However, some lands are cultivated while others are not because the settlers are not proactive.
- For oil palm settlers, the results are very good and profitable. Meanwhile, the opposite happened to the rubber settlers. They have to face low prices and issues with many diseases that attack rubber trees. R&D team needs to do something.
- Moreover, there is also a room for new crop suggestions, particularly interim crops during the replanting period because oil palm trees with a spacing of 28-29 feet will leave some space when replanted. As a result, it can be occupied by new crops, such as high-tech crops. Hence, the suitable areas can be added on with the short-term cropping.
- FELDA practices the existing three models for replanting: a) The settlers handed over the replanting to FELDA without receiving subsistence money. After 3 years, FELDA will hand it back to the settlers to manage themselves. Especially for settlers who have no debt because the cost of replanting has been covered by the Replanting Fund before. b) All crop matters are managed by the settlers themselves. Then, the settlers can make a claim from the Replanting Fund of RM17,000, and c) Settler's hand over all replanting matters to FELDA and receive a subsistence of RM200-RM500/month for 3 years in duration.
- For the second generation of settlers (and more), it is recommended for them to adapt the original model of farm management which is to work on the land in groups. Most settlers are given lands in hilly areas and the location is far from home or difficult to access. This is one of the reasons many settlers that work individually were not successful. This issue requires a crop land suitability analysis.
- The issue of the use of 10 acres of land – it is recommended that the farm should be managed in groups and regulated by FELDA (either directly under FELDA or FELDA subsidiaries, e.g., FELDA Technoplant).
- The main commodity crops, such as palm oil and rubber tree, should be maintained. If anyone wants to implement new crops, he or she must work with other agencies. This will be a big challenge that will necessitate extensive research.

ii. ***Element on New Physical Development (Business Centre, Residential Compounds)***

- Housing for the second generation must be given extra attention because they are the driving force for the progress of FELDA developments. The lack of the second-generation dwellers is due to limited residential area. This affects the efforts to develop FELDA's lands/estate.
- The settlers cannot be expected to manage without the participation of the second generation. This can lead to a major difficulty in cultivating FELDA lands in the future.
- There is approximately 10% of the land reserved in every FELDA scheme. The reserved vacant land is to cater to any economic or physical development projects that are required. For these lands, FELDA has an agreement with the State Government, and the land is under the jurisdiction of the State Government.

iii. ***Element on FELDA Agropreneur***

- There is a significant issue regarding other income of settlers through a *Program Pembangunan Peneroka* (PPP). The program is to focus on the second generation for their additional income to prevent out-migration from them.
- This can be materialised through an establishment of agropreneur as a diversified economic activities platform in the FELDA scheme.

FGD with FELDA Representatives: FELDA Lands Management Office and Person In charge for Program Pembangunan Peneroka (PPP)
The special session was conducted on 28th July 2021 via an online Google Meet. The session aimed to obtain further information regarding FELDA lands estate management and Program Pembangunan Peneroka (PPP) and their feedback towards the SHBU's FELDA Model. The brief critical findings are summarized as follows:

- This research is timely as the organization need to cope with planning for future possible development in FELDA settlements and crops lands and to enhance the PPP programmes to improve settlers' income, prosperity, and social well-being.
- The proposed model met with the current state of the FELDA land development and PPP programme. Close cooperation is needed during the research progress, especially on eGIS digital data and other support information and expertise.

- There are few recommended potential case studies to be undertaken in the research, and they will be determined soon based on the selection of criteria set. The potential case studies are included but not limited to Tenggaruh, Rokan, Gemenchih, Besaut, Trolak, and Raja Alias 2.

Result from Socio-economy Survey: FELDA's 2nd Generation and above
The important results derived from the 39 sampled questionnaire set are summarized as follows:

- Majority of the respondents were from Johor (56.4%), followed by Perak (17.9%), Pahang (12.8%) and the remaining from Negeri Sembilan, Selangor and Kedah. There were four settlers, 32 from 2nd generation and three from 3rd generation and above, and 87% living in FELDA settlements.
- The majority of the respondents work in FELDA settlements (as settlers, estate-based workers, business owners, others) with less than RM2,500 monthly incomes.
- Also, the majority of them are involved in Model A and Model C of estate land operations (Products and planting manage together by FELDA), and also about 20% is involved in Model B (manage separately as individual). Based on personal experiences, most of them (71%) agree that estate land operation with the original model is more profitable and successful to lift up their livelihood. So, most of them will continue or change into estate land operation under the FELDA management system.
- To sustain their livelihood, settlers require affordable housing development scheme in the settlement and other improvised economic activities to be introduced especially for the 2nd generation and above. With house ownership, they will remain in the settlement and contribute to the FELDAs' projects and socio-economic transformation.

The above brief findings confirm that elements related to SHBU can be derived such as Strategic FELDA management for plantations, the needs for residential compound and business centre. From documents analysis, FGD and the questionnaire the development model will be formulated and refined to ensure reflections towards the national rural policies that resonate with the Sustainable Development Goals (United Nations, 2020). The outcome should enable FELDA to sustain the highest return in more comprehensive forms that is not only for the income of current settlers but also for the next generations of FELDA communities.

PROPOSED SHBU MODEL

By working on the analysis, Figure 1 demonstrates the formulated conceptual model of the Sustainability and Highest-Best Use (SHBU) namely: FELDA industries-based crops (FIbC) and SHBU plan management (SPM) from the HBU domain; and the remaining FELDA business centre (FBC), FELDA residential compound (FRC) and FELDA agro-preneur (FAgP) are from the sustainability domain**.**

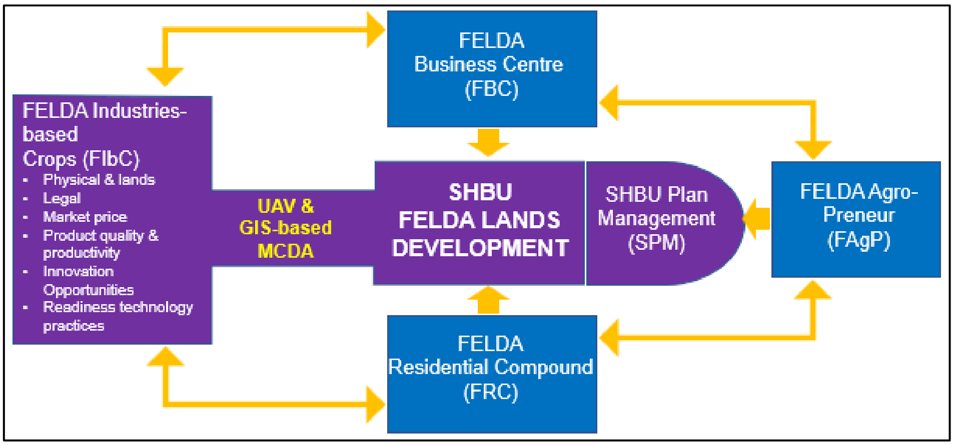

Figure 1: The Sustainable and Highest, Best0use (SHBU) Model for FELDA Lands Development

APPLICATION ON CASE STUDY AND THE PROPOSED STRATEGIES

Furthermore, in -depth interview has been conducted in one of the case study areas which is Tanah Rancangan Bukit Rokan, Negeri Sembilan in order to propose strategies for the model. The interview was conducted so that the researcher can understand the scenario that currently exist in FELDA settlement within the context of the conceptual SHBU model. The discussion conducted with the Manager of FELDA Bukit Rokan and the Head of Settlers for their views, suggestions, and the challenges in adopting the SHBU model for crop plantation and future development in the area. Table 2 shows the critical summary of the interview in Bukit Rokan. Next, Table 3 will showcase a list of strategies proposed for one of the elements for SHBU model. This to depict the process of formulation of a comprehensive SHBU Model for reference by FELDA and other rural land development agencies that might benefit from this model.

Table 2: Summary findings on five dimensions of the SHBU at FELDA Bukit Rokan

FELDA Industries-based Crops
● Agreed with this dimension. ● Rubber trees are the major crop, and palm oil plantations will soon replace them. ● Planning for papaya plantation for 30 acres of vacant land. ● The oil palm plantation areas are flood-risk areas that require mitigation plans.
FELDA Business Centre
● Agreed with FELDA Business Centre proposed in the area. ● However, the location should be in the FELDA area to cater to all FELDA settlements in the region. ● Focuses on business activities and the market for PPP agricultural products. ● The residents also need public facilities such as a school.
FELDA Agropreneur
• Focuses on the PPP project to attract youth involvement to generate extra income. • The area faces issues with jobs opportunity for the next generation. • Currently, about 43 residents are involved in the PPP project. ● suggestions are made for ecotourism activities such as Homestay, flying fox, archery, kayaking and shooting to diversify the economic clusters.
FELDA Residential Compound
• Agreed with this dimension. • There is a housing demand from the 3rd and 4th generations. • FELDA has provided 100 units in the FELDA region, but there is still a shortage to cater to the demand.
SHBU Management Plan
• 92% estate area is under FELDA management, so it is easy to decide on the plantation and other related matters. • FELDA provides a lot of initiatives and assistance to ensure the welfare of settlers & workers. i. Facing a shortage of labour.

The SHBU models assist in identifying issues in FELDA settlement as in Table 2 and facilitate the development of strategies and actions to curb the issues as depicted in Table 3. Thus, the following will outline strategies from one (1) of the Dimension in SHBU Model which is the dimension for Felda Business Centre.

Table 3: Strategies for Element 3 - FELDA Business Centre (FBC)

Component of development	Strategies (Application and Monitoring)
1. Economic Development	i. Development and provision of commercial and small business spaces in strategic and accessible locations ii. Promoting Homestay programs - Collaboration with authoritative agencies to organize tourism exhibitions, food, and cultural events for local and international. iii. Development and provision of appropriate premises (collection centers, processing, logistics, etc., booth space) iv. The involvement of rural youth in the entrepreneurial sector is enhanced with various initiatives such as training and technical, incentives, and capital. v. Introduction to new areas of the economic sector, such as the digital economy and green economy
2. Infrastructure Facilities	Development and provision of appropriate infrastructure
3. Service Centre	Provision of one -stop centers for business consultation and advisory services such as OUTREACH programs for villagers (not only for selling fertilisers) and youth.
4. Human Development	i. Encouraging communities to use e-commerce in the marketing of rural products – products PPP ii. Provide training centres and modules – enhance skill sets for the young generation to continue the legacy as modern settlers. iii. Youth-centric development and motivational programs.

CONCLUSION

This study has been exciting and challenging to be carried out. Even though the focus mainly riveted on FELDA management, the researcher has no intention to highlight any negative aspect of the organization. The study unravel new information on various initiatives that FELDA management has carried out to develop settlements and agricultural areas. The establishment was comprehensive and covered various aspects. However, since it involves large areas and is located all over Malaysia, issues and problems will be part and parcel of a large organisation, which also means that it needs monitoring and constant improvements. The study successfully achieves all the objectives. Factors of elements for SHBU have been presented through five (5) Dimensions or elements of SHBU model. The exploration of numerous literatures, discussion with the focus group, and FELDA management on the earlier stage contribute to the establishment of the overall model. Furthermore, the SHBU model was applied in the case study that the result assisted in strategies formulation. These strategies will serve FELDA land development to move towards sustainability and high-income returns.

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THE HERITAGE AND NARRATIVE OF CONFUCIAN COURTYARD AND ARCHITECTURE IN SUSTAINABLE DEVELOPMENT IN SHANDONG, CHINA

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Abstract

In recent decades, China has witnessed a miracle of rapid urbanisation, and the development of traditional Chinese architecture has faced challenges as well as opportunities. Improper planning has undermined the well-being of residents, and many historic buildings have been demolished. Under the slogan of "high-quality urban development", the value of traditional architecture is rarely mentioned. Therefore, research into architectural heritage and urban sustainability is necessary. This study focuses on Shandong Province in China, the birthplace of Confucianism and, to a large extent, the long history of Chinese culture. By studying courtyard architecture under the influence of Confucianism, the aim is to reveal the cultural profile of the new urban era while critiquing the problems in the urban planning process. The study adopts a qualitative method based on the researcher's field investigation and data collection, as well as one-on-one interviews with experts, to collate typical cases for analysis. In addition, this study also intervenes from a narrative perspective to facilitate the exploration of the value of architecture. The findings suggest that courtyard architecture embodies Chinese aesthetic and philosophical thinking, has theoretical and practical implications for living environments, communities, and urban development, and brings new insights that can better achieve sustainable goals while expanding the existing knowledge of architecture and courtyards.

Keyword: Cultural heritage, courtyard, narrative, sustainable development, Confucian architecture, Confucianism

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INTRODUCTION

China's urbanisation development has taken a unique path since the country's reform and opening up in 1978, transforming the country in a relatively short period of time (Guan, Wei, Lu, Dai, & Su, 2018). China's urbanisation rate has climbed from 17.9% in 1978 to 64.7% in 2021, generating a global urbanisation miracle (Ma, Li, Li, & Yuan, 2022). However, in this context, there are also protests over real estate development and conceptual disagreements over land and building ownership (Pils, 2014). Furthermore, researchers Alqahtany and Aravindakshan (2021) noted that while urbanisation is recognised as a positive force for economic growth, this trend is having a negative impact on its cultural heritage and environment, particularly by risking the loss of historical areas and heritage that are of great value to the history of human development. Traditional regional cultures and historical memories are gradually disappearing. This has also been studied and explored by many scholars. Globalization, which seeks to bring world societies closer together and form a single entity based on commerce, politics, and communication, diminishes the significance of cultural variations across societies and, consequently, local cultural identities (Ceylan, 2022). In addition, residential houses account for a large share of the building stock in developing countries and can have a lasting impact on the local and global economy and environment. Crises regarding cultural identity can have an impact on the built environment and on the quality of life of the people living in it (Bougdah, 2018).

Hence, with the announcement in 2022 that China will "promote the comprehensive revitalisation of the countryside", traditional culture and architecture should continue to be researched and preserved, and Knapp (2006), a specialist in traditional Chinese architecture, has a forward-looking approach to settlement patterns, building techniques, spatial organisation and folk narratives. In addition, Mazinanian et al. (2022) mentioned that shelters are essential to humanity. Humans have been developing a variety of residential architecture to protect themselves, one of which is the courtyard, and many urban civilisations have developed courtyard dwellings for centuries. The proverbial prototype of spiritual and celestial attributes, Chinese courtyard architecture demonstrates an architectural union between man and nature (Çeliker, Çavuşoğlu, & Öngül, 2014). Baiz and Fathulla (2017) referred to the improvement of courtyard-style architecture from defence to use, namely social place, environment, and culture, which are quite important in the culture of design privacy. These habits have changed with global development and the exchange of world cultures, and in response, increasingly more scholars have begun to study the impact of courtyards on the living environment. With this, the long-lost identity and spirit of the hamlet can be restored (Zakaria, Alauddin, Sazali, & Hassan, 2022).

This study focuses on the cradle of Confucian culture, Shandong Province, where most traditional buildings have courtyards. The courtyard has developed through an entire economic, cultural, and political period and is not only a functional space, but also a place where folk narratives, creativity, and a sense of place are displayed. And while Confucianism, the foundation of ancient Chinese culture, served as a vehicle to display the dominant social consciousness and ideology of the people through architecture, these traditional courtyard legacies have been unfairly forgotten with urbanisation. Therefore, this study highlights the activities that take place within the courtyard space through the lens of narrative, which in turn completes the regional construction of architectural heritage conservation to better discuss how to achieve sustainable development from small spaces to large cities.

LITERATURE REVIEW

Urban Alienation

Urbanisation, the most ambitious and complex historical change that China is undergoing, has become the most profound component of economic and social development. Not only is the countryside caught up in this process, but almost every household cannot be completely insulated from it (W. Han, 2018). A city can be seen as an integration of various elements undergoing continuous change over time, that is, across several generations (J.-H. Han, 2015). In the same vein, Sun et al. (2019) suggested that conventional urban construction has caused the loss of urban memory and cultural identity by severing the customary environment. Similarly, changes in spatial patterns resulting from development may also lead to a loss of local identity (Harun, Jaffar, & Mansor, 2021). Some researchers have suggested that architecture can be considered a unique cultural component of the country (Darmayanti & Bahauddin, 2020). It is undeniable that the continual cultural tradition of Chinese architecture has been alienated by domestic strife and foreign invasion, and it has fallen into an imbalance of development together with the huge economic leap forward in the new China, causing a sort of interruption and extinction (Lin, Li, & Yin, 2014). It is worth noting that people in many societies are acutely aware of the resulting loss of cultural identity in their local built environments, which has prompted scholars and researchers to advocate for the preservation of the distinctive architectural identity of urban areas through the development of approaches that respect each region's cultural heritage (AL-Mohannadi, Furlan, & Grosvald, 2022).

Confucian Architecture

Buildings are an integral part of every community. In addition to their fundamental role of providing shelter and space for diverse activities, buildings also contribute to a society's culture, heritage, and wealth and have an impact on the natural environment (Agha & Kamara, 2017). In addition, through the artistry and technology used in the building's design and construction, the presence of heritage buildings adds to providing a general peek into the past of a particular community or civilisation (Salleh & Mohtar, 2020). Confucius, however, has a “sacred” status in China. Confucianism is the foundation, epitome, and symbol of traditional Chinese culture (Yu, 2021; L. Zhang & You, 2017). The city created by Confucianism represents the correct structure and order of the universe (Tceluiko, 2019). In reinterpreting urban space, from metaphorical expressions to mythological constructions, it provides a corresponding ideology and strategy for the dissemination of urban culture. Thus, the philosophical concepts of “Ren, Li, the Doctrine of the Mea, and Harmony” advocated by Confucius are reflected in the architectural forms of order, hierarchy, and symmetry. Figure 1 shows how Confucianism is presented in official and private buildings.

Figure 1: The Forbidden City and the Chinese Folk Courtyard

Courtyard Narratives

It is known through the literature that courtyard-style architecture influenced by Confucianism carries the 'form' and 'meaning' of architectural culture (Luo & Huang, 2022). One study suggests that courtyards in China typically account for approximately 40% of the total area of a house (Bracken, 2013). However, the impact of urbanisation has led to the decline of traditional Chinese architecture and a significant homogenisation of architectural styles, while the contemporary development of the courtyard as an element representing national identity is unclear. In addition, the modern trend of residential relationship fragmentation has diminished people's sense of belonging to space. Whereas in the past, people constructed courtyard homes not to stand out, but to live in accordance with their cultural and social perspective or structure (Hatipoğlu & Mohammad, 2021). For instance, this traditional painting in Figure 2 shows the story of an ancient Chinese courtyard.

Figure 2: The Dream of the Red Chamber
Source: (By Sun Wen, a Chinese painter of the Qing Dynasty)

The inner and cohesive nature of the traditional Chinese courtyard reflects the spiritual core and introverted quality of the Chinese people (Guo & Dou, 2022). The traditional Chinese courtyard can also be considered a successful sustainable design strategy because of its dual functions of privacy and security (Huang, Chiou, & Li, 2019). Mo et al. (2022) suggested that the incorporation of folk culture in the construction of courtyards and the use of objects to convey feelings often employ narrative techniques. Narrative discourse has largely changed the inherent patterns and cognitive schemata of architecture, as various narrators have joined the architectural narrative, and the idea of architecture and space has evolved from an enclosed entity and enclosed volume to a site of behaviour and a carrier of culture (X. Zhang, Ni, & Tao, 2019).

Unpredictably, the outbreak of the epidemic in 2020 has prompted a higher demand for courtyard spaces, where the influence of the traditional land system has increased the sense of attachment to the living space and the importance of improving amenities. Therefore, understanding the architecture of courtyards under the influence of typical Confucian culture is important for the sustainable development of the communities and cities in which they are located.

RESEARCH METHODOLOGY

This study focuses on the birthplace of Confucianism culture, Shandong Province, China, as shown in Figure 3. Most of the traditional buildings in this area have courtyards, and there are a lot of them. For the research method, a qualitative method was chosen, and purposive sampling and snowball sampling were used. Creswell and Poth (2018) argued that a non-probability approach would collect enough data and help the study as the sample grew.

Figure 3: Current map of Shandong Province (1949－)
Source: (Qin et al., 2019)

The study was divided into three stages, as shown in Figure 4. The first stage was a combining of the literature to assess recent studies that fit with the theme of this study. The second stage was through the researcher's observations and three experts' interviews, which covered the caveats of studying Confucian architecture, namely the excavation of architectural components and narratives as well as the identification of cities in central and western Shandong province that have preserved more courtyard-style buildings. The third stage is based on the collection and analysis of data to infer the impact of Confucian culture on courtyard spaces, architectural groups, and cities and derive strategies for sustainable development.

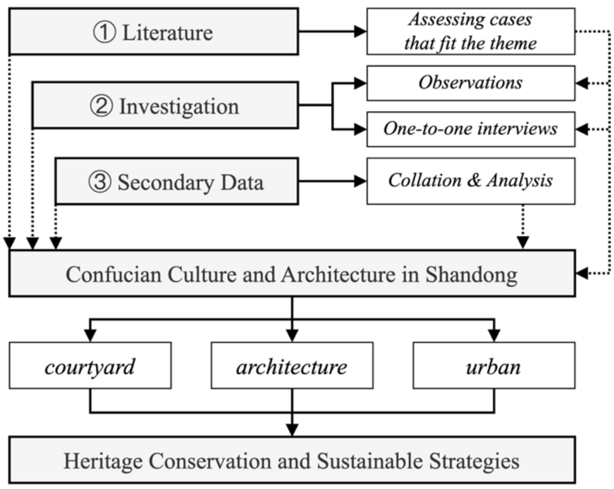

Figure 4: Research procedure

ANALYSIS AND DISCUSSION

Through data combing and expert interviews, the researcher analysed the architectural heritage characteristics of different cities in the central and western regions of Shandong, as shown in Table 1. Furthermore, the researcher evaluated and chose three courtyard-style buildings for on-site research: the Confucius Mansion in Qufu, the Ji Family Courtyard in Linqing, and Qiming Street in Jinan. Based on the stories and historical events told by the locals, the potential, and opportunities of the cities in Shandong Province were identified. The analysis and conclusion are therefore based on the available information and data, cascading from the small courtyard pattern to the architectural heritage to urban planning.

Table 1: Categories of Confucian Courtyards in Central and Western Shandong

No.	City name	Architectural Heritage Features	Geographical Area
1	Jinan	A city group centred on Mount Tai. It is mountainous and therefore the overall architecture is mostly made of stone, which is relatively well preserved. The city of Qufu (which is part of the city of Jining), for instance, is an important birthplace of Confucian culture.	Central Shandong
2	Zibo		
3	Jining (Qufu)		
4	Tai'an		
5	Liaocheng (Linqing)	The western part is situated on an alluvial plain and is more rustic in style, with relatively simple structures and a rational layout reflecting the cultural	Western Shandong
6	Dezhou		

No.	City name	Architectural Heritage Features	Geographical Area
7	Heze	influence of Confucianism. The building materials used are stone and timber.	

Source: Author's research

The Positive Influence of Confucianism in the Courtyard

Previous research has noted the importance of Confucianism in architecture. Through observation and literature filtering in the central and western regions of Shandong, it is possible to understand that Confucianism corresponds to the universe, the rules of operation, the ethical framework, and the social structure.

It is undeniable that the development and achievements of ancient China were shaped by Confucianism. The sense of harmony and stability promoted by Confucianism is reflected in the architecture, for instance in the rational division of spatial order, which ensures privacy while maintaining the family ethics of Chinese acquaintance society. The courtyard and Confucianism thus play a crucial role in the revival of traditional Chinese architecture in Shandong province. It opened the connection between people and place. And the link between the location of the building and the urban architecture is one and the same (Malpas, 2012).

Figure 5 shows the key components that make up the sense of place in the Confucian courtyard, namely the daily activities, spatial planning, and narratives within the courtyard. In today's urbanization, the imagery of the Confucian courtyard has a cultural metaphorical nature as well. In terms of its aesthetic and philosophical connotations, the Confucian courtyard is also an extension of the aesthetics of dwelling, from the large to the national and the small to the family.

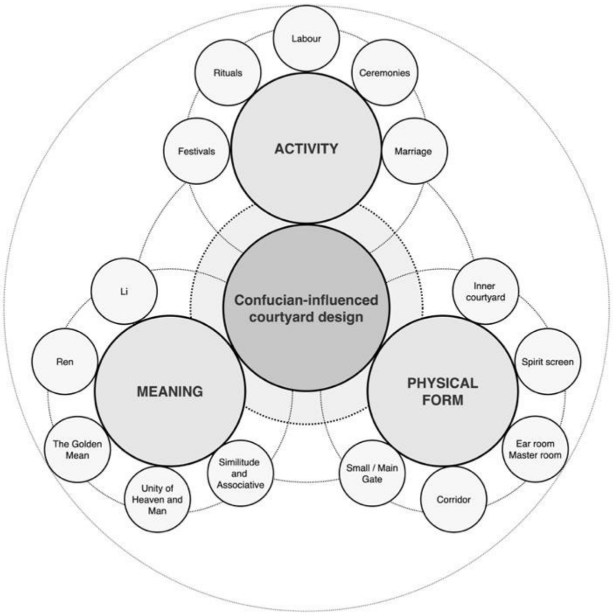

Figure 5: The components of the sense of place addressed by the Confucian Courtyard
Source: Author's illustration

Sustainability of Traditional Buildings in the Community Environment
The contextual clues of Confucianism are clearly visible in the development of ancient Chinese architecture and have had a profound impact. Based on the Confucian principle of the middle ground, it is important to talk about the relationship between inheritance and development, both for individual buildings and for architectures that are put next to each other.

However, according to literature and interviews with experts, research on traditional courtyard architecture has so far focused more on microclimate impacts, thermal comfort issues, and engineering structures. In fact, Confucian architecture encompasses not only these, but is also more culturally relevant in terms of its heritage value. This study offers new insights into the conservation of architecture and heritage through the study of building components, construction materials, and cultural narratives. Figure 6 demonstrates the translation from a literature review to a concrete implementation in terms of content. At the same time, the courtyard, a domestic, inward-looking activity space, when present as a settlement, collectively communicates a positive and sustainable living environment.

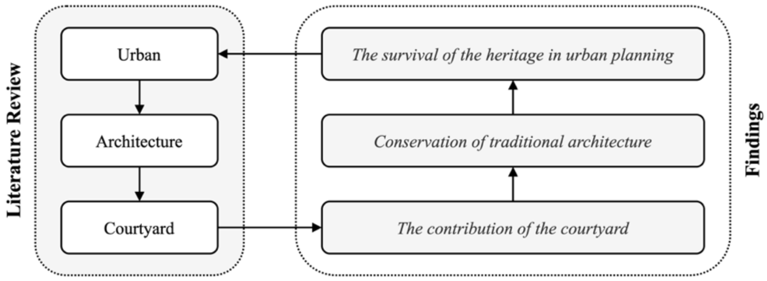

Figure 6: Transformation of literature to research findings
Source: Author's research

As shown in Figure 7, observations of the buildings in this study, which contain architectural components such as flying eaves, ridges, tiles, and brickwork, are recorded. It reflects the people's reverence for nature and their good wishes for stable and harmonious family relationships, which are in line with what Confucian culture advocates.

Figure 7: Narrative connotations of architectural components
Source: Author's research

Architectural Heritage Insights for Urban Planning

In terms of visual shapes, spatial axes, scaled facades, and cultural semantics, Confucian architectural spaces go beyond functionality itself. The concept of courtyard architecture can be obtained by observing the behavioural habits of the inhabitants, which can exist in contemporary communities as a kind of shared space. In addition, traditional rituals and folk festivals inspire a sense of nostalgia and homesickness, thus better sustaining cultural heritage. Thus, the courtyard architecture and heritage under the influence of Confucianism are an inspiration for the sustainable development of towns and cities in the present day. Figure 8 summarises the findings of the research discussed in this study. The cities of Shandong province, with their privileged location and radiant Confucian culture, have many opportunities and possibilities for future development. The preservation of courtyard space as a living environment for small family units, and the existence of communities together constitute a characteristic local cultural narrative. The Confucian cultural heritage thus pushes the sense of place of courtyard architecture and urban sustainability into a better future.

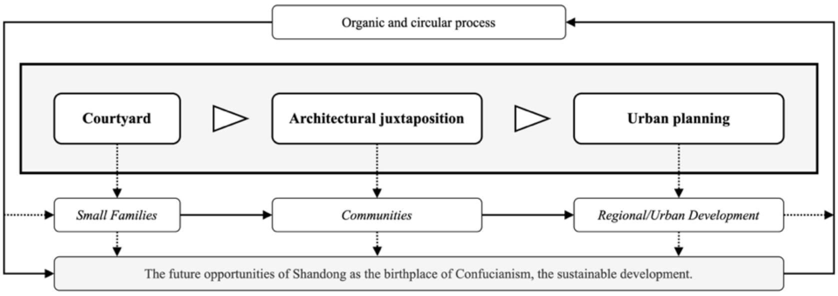

Figure 8: The components of urban planning under Confucian influence

CONCLUSION AND SUGGESTIONS

This study highlights the continued relevance of Confucian culture as a dominant social consciousness and ideology that has influenced China for thousands of years, both in courtyard-style architecture and in the sustainable development of cities today. The findings reveal that the Confucian courtyard, as a representative part of traditional Chinese architecture, is still in a phase of exploration. In this regard, this study initially explores the meaning of this architectural form and the forms in which its sense of place is constructed. This study is a pioneering attempt to provide new insights into the architectural courtyard and enrich the literature on Confucian narratives. In addition to the revitalisation of traditional architectural heritage, to achieve sustainable development for the city, the researcher also makes corresponding recommendations.

- Cities in Shandong Province should focus on the heritage and preservation of Confucianism, especially in the implementation of planning concepts with greater care.
- Establish links between the old and new cities to ensure that the voices of traditional architectural heritage conservation are heard.
- Protecting the value of existing traditional houses rather than bulldozing and rebuilding them, with the preservation of the original narrative and materials as a basic guideline.
- Housing plans should also respect the basic pattern of Confucian courtyards and not break the traditional rules of layout.
- The relevant authorities should set up pilot projects to invest in and encourage owners to participate in the rehabilitation of courtyard buildings, so that they can be reused, and the folk narrative perpetuated.

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TRANSPORTATION BARRIERS CONFRONTED BY MOBILITY-CHALLENGED TRAVELLERS IN KLANG VALLEY

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Abstract

Accessibility enables individuals' full participation in society, which results in social justice and equity, thus promoting social sustainability. However, research indicates that physical barriers in the built environment impede disabled people, resulting in marginalisation when their inclusion is tied to physical space. Commonly, accessibility of the built environment is evaluated using an access audit with a predetermined checklist. Little effort has been made to explore disabled people's life experiences accessing the city centre. This qualitative study involves twenty go-along interviews with mobility-challenged travellers to learn about their experiences using land transportation from around Klang Valley to Kuala Lumpur city centre. Mobility-challenged travellers, notably wheelchair users, still need help to reach their destination with the current transportation services. In general, transportation use in Klang Valley has several issues, including the lack of accessible facilities and lack of safety concerns from service providers. These issues have psycho-emotional impacts on disabled people.

Keywords: accessibility, barriers, go-along interview, psycho-emotional

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INTRODUCTION

Access to the built environment is a basic human right (Frías-López & Queipo-de-Llano, 2020). It is a spatial issue intersecting human biological and psychological conditions that differ based on intrinsic and extrinsic factors (Shakespeare & Watson, 2016). Accessibility promotes social sustainability and fosters sustainable development (Dempsey et al., 2011). In modern societies, where everyone has the right to a life without physical or mental obstacles, accessibility has emerged as a pressing issue (Yakob et al., 2022). For disabled people or OKU (from the Malay '*Orang Kurang Upaya*', a commonly used term in Malay, English and other languages in Malaysia), accessibility enables them to lead more independent lives. Nevertheless, an inaccessible built environment often creates unjust situations. It contributes to poverty, lower education, and poorer health among disabled people (WHO & World Bank, 2011), resulting in fewer opportunities to engage in built environment activities than non-disabled people (Bailey et al., 2015).

In general, prior research investigated the (in)accessibility of buildings (including transportation terminals in Malaysia) by using accessibility checklists in the access audit exercise (see Hashim et al., 2012; Kamarudin et al., 2014 for example). However, OKU's lived experiences, including their psychological and emotional views, have received little consideration, despite the dynamic interaction between disability and the built environment. Data used in this paper is part of the first author's doctoral thesis, entitled "*Physical Access for Disabled People's Inclusion in the City Centre: The Case of Kuala Lumpur*" (Kamarudin, 2021), completed in 2021. By employing the go-along interview method, findings of barriers in the built environment in the original research were divided into (1) transportation, (2) buildings and (3) street-level environment. The authors utilised the data from the thesis for their current research on strengthening access audit practice.

This paper is an extension of work presented at the 3rd International Conference on the Built Environment and Engineering, held in Putrajaya, Malaysia, in 2022, with the aim to explore transportation barriers faced by OKU when travelling to the KL city centre. This paper is expected to contribute to current knowledge of accessibility by revealing how OKU interacts with transportation-related services in the Klang Valley. This paper acknowledges that disability is, to a large extent, caused by discriminatory processes within society, as proposed by the social model of disability. Therefore, it is generally preferred to use the term 'disabled people' instead of 'persons with disabilities' to emphasise that disability is not solely an inherent trait of an individual but is shaped by societal barriers and attitudes.

THE SOCIAL MODEL OF DISABILITY

The social model of disability views society as an external factor contributing to impairment by producing a disabling environment. An extended social-relational model of disability views 'disability' encompasses both structural and psycho-emotional (personal experience) dimensions (Reeve, 2014). The lack of physical access to buildings is an example of a structural dimension, that impedes disabled people's career and educational opportunities, resulting in exclusion. The psycho-emotional dimension of disability includes how emotionally disabled people react to social exclusion and physical barriers (i.e., feeling humiliated while being gazed at, and frustrated when confronted with inaccessible buildings).

Berghs et al. (2019) suggest that the social model may switch to a model that can better uphold and carry out rights. They call it a social model of human rights with "*the right to live a dignified life, as well as to live in an environment that enables people to flourish with disability*" (Berghs et al., 2019, p.1034). Hence, the authors include the 'voice' and participation of mobility-challenged city travellers in identifying physical barriers to transportation.

DISABILITY-RELATED TRANSPORTATION ISSUES

For disabled individuals, an accessible door-to-door transport chain could facilitate independent mobility with a smooth journey (Frye, 2011; Hanson, 2004). Public transportation ought to adhere to set schedules, be reliable and safe, provide excellent service, make efficient use of resources, and accommodate the needs of riders (Khalid et al., 2014). Evidence from various contexts, however, demonstrates that not all links can be accessed. According to Hepworth and Ducatel, cited by Marston (2002), "*public transportation is all about anxiety, uncertainty, and waiting*".

In the United Kingdom, regularly used buses have low floors, giving wheelchair users priority boarding. Yet, according to Ferrari et al. (2014), the vertical and horizontal gaps between the train and platform (for stations built around 150 years ago) contribute to the 50% longer travel times for wheelchair users for rail services in London. Accessibility upgrades were prioritised for high-demand stations. Although measures were taken to reduce physical barriers, such as elevating a part of the platform to align it with the train doors, a substantial amount of work remains to allow step-free access from the street to the platform (Ferrari et al., 2014). Nonetheless, in 2018, Transport for London published pamphlets on how to avoid stairs at tube stations and additional guidance for disabled people and elderly passengers with transport access concerns (Transportforall, 2018).

In the Global South context, Zimbabwe presents an example where many bus drivers refuse to transport disabled passengers, which is a prevalent issue faced by the disabled community. Some reported having to purchase two tickets: one for the passenger and one for the wheelchair (Frye, 2011).

Meanwhile, it has been noted in Klang Valley, Malaysia, that buses do not adhere to schedules and that their drivers have negative attitudes towards OKU, which is frustrating (Mothiravally et al., 2014). These instances demonstrate that transportation barriers are socially constructed. A lack of accessible parking, inadequate parking size, inaccessible buses, and noncompliance to regulations and standards for access and facilities in the transportation hub (such as the absence of guiding blocks for the blind and lack of signage) all contribute to OKU's difficulty in using transportation in Malaysia (Hashim et al., 2012; Isa et al., 2016; Kamarudin et al., 2014).

Rahman et al. (2018) asserts that the location of OKU's home in relation to nearby facilities is crucial, as it can significantly affect their mobility and level of independence. Ideally, their home should be situated in close proximity to essential facilities with easy accessibility, enabling them to move around with minimal supervision. Nevertheless, there are still instances where OKU needs to travel to the city centre for certain reasons. Therefore, it is crucial to explore the availability and accessibility of transportation services for OKU to access the city centre.

PRIMARY DATA COLLECTION: GO-ALONG INTERVIEW

In a go-along interview, the interviewer walks alongside the interviewee as they talk, a technique frequently used in ethnographic research (Kinney, 2017; Zahari et al., 2018). Evans and Jones (2011) assert that walking interviews produce richer data because participants are more likely to be motivated by meanings and connections to the environment and less likely to try and provide the 'right' response. Through participant observation and conversation, researchers can learn about the participants' emotions by observing their facial expressions, body language, and intonation (Kamarudin, 2021; Zahari et al., 2018). Analysing occurrences that have psycho-emotional consequences for OKU while experiencing transportation barriers (and facilitators) needed in-depth study instead of depending on surveys and statistics.

With each participant, the researcher allotted time for a ride-along using the research participant's preferred mode of transportation, such as taxis, buses, and trains, as well as a walk-along in public and travelling by cars driven by the participants. During the go-along journey, the accessibility of transit hubs and stations was also evaluated. The participants' homes or any other convenient meeting location close to their homes served as the starting point for data collection to identify barriers that participants faced when using transportation.

Recruitment of participants

The study included twenty volunteers. Those with mobility issues were selected because their daily lives are more affected by physical barriers in an inaccessible environment. The participant had to be at least 18 years old (adults) and willing to engage in the study, which included travelling with the researcher to the KL city centre. They could be a frequent or infrequent visitor to the city centre who resides in Klang Valley.

Since finding participants was difficult, the snowballing technique was used to recruit participants. The first person contacted was on the researcher's contact list from prior volunteer work. Potential participants were contacted by telephone to obtain their initial consent to participate in the study and to set a time for the go-along journey. Before the journey started, the participant received the consent form and participant information sheet. Participants were asked if they knew anybody who would be interested in taking part in the study. The vast majority of individuals contacted gave their consent to participate. Two contacted straightly declined to participate, and two others cancelled after scheduled appointments.

The use of specific mobility aids was not a requirement to take part in the study. The participants' attributes are detailed in Table 1 below.

Table 1: Participants' attributes

Walking aid	**Health condition**	**Sex (M/F)**
Manual wheelchair	Spina bifida	1 M / 2 F
	Polio	1 M
	Spinal cord injury	5 M / 1 F
Motorised wheelchair	Cerebral palsy	2 M
	Congenital amputation	1 M
Skateboard	Polio	1 M
Crutches	Cerebral palsy	1 F
	Single-leg amputee	1 M
Prosthetic leg	Single-leg amputee	1 M
Unaided	Clubfoot	1 F
	Acquired brain injury	1 M / 1 F

Source: Adapted from Kamarudin (2021)

Ten of the twenty participants used manual wheelchairs (those with polio, spina bifida, and spinal cord injury). Three individuals used motorised wheelchairs (those with cerebral palsy and congenital amputation). One person (a polio survivor) used a skateboard, two people (those with cerebral palsy and a single-leg amputee) used crutches, and one person used a prosthetic leg (single-leg amputee). Three individuals were walking unaided; one had a clubfoot, and two had acquired brain injuries.

RESULTS AND DISCUSSION

The four months of fieldwork data collection were divided into individual analyses, which were then combined using analysis processes, i.e., transcribing, coding, and theme development. Mobility-challenged travellers place a high value on having an accessible built environment and transportation services that permit them to move around freely. The go-along interviews, however, reveal that not all transportation services are disabled-friendly. Due to the numerous physical barriers, independence was not always possible.

The diversity of physical mobility limitations aided the researcher in gaining a deeper understanding of the needs of participants while travelling using land transportation. Despite having similar mobility aids and impairments, each participant had unique abilities, needs, and ways of negotiating barriers. A lot can be learned about OKU's relationship to accessibility, the value of providing access for them, and how 'disabled' they felt in an inaccessible setting from the go-along interview. This go-along interview method emphasised OKU's genuine experiences using various forms of transportation, which could not have been learned elsewhere.

Mobility-challenged travellers, particularly wheelchair users, face numerous obstacles when attempting to independently use different modes of transportation. They require more assistance from service providers regarding the provision of physical access in enabling their inclusion. While some OKU were willing to accept assistance, the majority felt they had the right to travel independently. Most wheelchair users feel insecure and uncomfortable in situations that require them to be carried to a different floor, such as at a train station. These emotions are one of the consequences that could prevent OKU from enjoying a social life. Some OKU would instead remain at home than risk their safety or be exposed to physical and emotional harm. However, how OKU perceived barriers varied based on factors such as age, impairment, motivation, attitude towards impairment (intrinsic factors), and the condition of the physical environment (extrinsic factor).

Bus-related facilities

OKU's mobility is aided by accessible low-floor buses with a flip-out ramp, wheelchair parking space, and priority seating on bus services. In addition, discounted fares are provided for them. Most wheelchair users appreciate accessible bus service because it eliminates the need for them to be transferred to the bus seat. However, it was obvious that accessible buses are lacking; hence, they do not cover all routes leading to KL city centre.

In some instances, accessible buses lacked maintenance. As shown in Figure 1 (a) (figures to be read from left to right), the accessible feature, such as the ramp, cannot be flipped out. Meanwhile, most bus stops have high kerbs without a kerb ramp or kerb cut, as shown in Figure 1 (b), and Figure 1 (c) shows how cars abuse bus stops by parking in front.

Figure 1: (a) Accessible bus with a maintenance issue, (b) High kerb without kerb cut, (c) Cars parked in front of a bus stop
Source: Kamarudin (2021)

Rail lines and facilities in the stations

Observations from the go-along journeys indicate that the rail services facilitate OKU's access to the KL city centre more than they create barriers. OKU passengers in trains and stations have benefited from numerous facilities, including discounted fares, priority seating, priority ticket counters, special gates, lifts, escalators, stair lifts, ramps, staircases with handrails, and accessible toilets. However, it should be noted that not all stations provide every facility necessary for OKU, despite the existence of regulations and guidelines. In some cases, the facilities that are available may lack legible signage, leading OKU to believe that they are not provided. Moreover, some stations are completely inaccessible, as depicted in Figure 2 (a), where passengers are required to climb up a bridge to reach the opposite platform.

Figure 2: (a) Inaccessible station, (b) OKU being assisted in getting to a different floor level, (c) Horizontal and vertical gap between platform and train door
Source: Kamarudin (2021)

Meanwhile, mechanical facilities provided at train stations (such as lifts and escalators) were frequently claimed to be under maintenance and thus unavailable to OKU. As a result, they must be lifted by passers-by to reach the intended level, as shown in Figure 2 (b). Figure 2 (c) depicts the gap between the platform and the train door, posing a risk for OKU, particularly for wheelchair users and those using sticks or crutches. The material used to make the train seats is also crucial in ensuring OKU's comfort and safety. With weak muscles on the right side of one participant's body, the participant easily slid from the seat when the train was cornering.

Taxi services

In terms of availability of vehicle options and size, ease of booking, prices, and driver attitude and service, participants who had used both taxi and e-hailing services preferred the latter service. The lack of storage space for a wheelchair is a physical barrier in taxis, as the natural gas vehicle (NGV) cylinder is usually stored in the boot of the taxi. The number of passengers that can be accommodated without sacrificing space for a wheelchair may be determined by the car's options and size. OKU has more control over their pick-up point with e-hailing due to the booking method. OKU also receive a competitive and predictable fare and better service from e-hailing drivers compared to taxi drivers because the e-hailing operator provides a review facility service in the e-hailing app, which helps to reduce discrimination against OKU. Furthermore, the driver and vehicle information in the e-hailing app made OKU feel more secure when using the service.

Wheelchair users, however, must be transferred from their wheelchairs into the vehicle. Problems arise for those who are unable to move themselves to the car seat and prefer direct access to the vehicle without having to be transferred. OKU feels physically uncomfortable when being lifted to transfer to and from the car seat, as depicted in Figure 3. In addition, it impacts their psycho-emotional state when they are carried in public, and people watch them.

Figure 3: Transferring OKU from the wheelchair into a car
Source: Kamarudin (2021)

Private transportation

The lack of accessible parking, particularly for wheelchair users, is the top concern for those who drive their own vehicles directly to KL city centre or train station. Only drivers with an OKU registration card and sticker are permitted to park in accessible parking spaces, but not drivers driving OKU passengers. However, it is common for non-disabled drivers to occupy accessible parking spaces even though they are not driving OKU passengers. Meanwhile, parking for motorcycles with a wheelchair compartment, as shown in Figure 4, does not exist.

Figure 4: Motorcycle with wheelchair compartment
Source: Kamarudin (2021)

Other transportation issues

A mobility van with a hydraulic lift or ramp is highly valued for those with limited ability to self-transfer into a vehicle, but the service is currently very limited. Besides those operated by charity associations, the main public transport operator provided the service at once. However, it was not available anymore when the go-along journeys were undertaken. Last but not least is the traffic congestion issue. Traffic congestion is inconvenient for everyone, but for OKU, being stuck in traffic might worsen their health (e.g., for those requiring scheduled toileting), no matter if they are using public or private transport.

CONCLUSION

This paper has contributed to a better understanding of physical access issues encountered by mobility-challenged travellers when using transportation and transportation-related facilities in Klang Valley. Overall, the current modes of transportation do not fully enable free mobility for OKU's inclusion. There are several issues concerning the various modes of transportation used by OKU in Klang Valley to access the KL city centre. First, accessible transportation-related facilities, such as accessible parking spaces, accessible buses, and physical access facilities, are lacking. Second, safety concerns which include the threat posed by the gap between the platform and the train door, the choice of materials for the facilities, and the danger posed by staircases and escalators in the transportation hub. Finally, on the psycho-emotional effects of the transportation barriers and the negative public perception of OKU. Some OKU may give up their journey due to the ongoing difficulty or overcoming these challenges. Even though individuals may use the same type of walking aid and have the same type of impairment, depending on their biography, they may perceive potential barriers in varying degrees.

Access to facilitate OKU's inclusion in the built environment should ideally begin when OKU leaves their home, using a range of transportation until they reach their destination. OKU are the expert in barriers as they experienced the barriers first-hand. Therefore, their voices should be considered when formulating policies and planning and designing facilities and infrastructures. The establishment of a go-along interview method in identifying barriers in the built environment is suggested to be integrated with access audits to strengthen ways to enhance accessibility in the built environment.

Hopefully, this paper provides insights that can assist policymakers and practitioners in the Global South, particularly for countries in transition, in improving their practices and, ultimately, the lives of disabled people. The presented findings are meant to facilitate planning and designing a more inclusive built environment. OKU can contribute to a more socially sustainable environment if given the opportunity to participate and be recognised in decision-making processes.

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WHAT MOTIVATES THE MALAYSIAN HOMEBUYERS TO GO GREEN?

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Abstract

There are various factors influencing purchase intention to invest in commercial green buildings, however, less discussion found on motivations to invest in green residential properties. The rigorous and extensive literature review identified three main motivations for a green residential property investment, namely, environment, social, and economic concerns. The data was collected by distributing questionnaires through survey methods to the green residential owners or residents in Penang and Selangor, Malaysia. The relative importance index is adopted to analyse the data from a sample of 171 respondents through a judgemental sampling. Based on the result, the researcher found that environmental concerns were ranked as the main motivating factor influencing green homebuyers' decisions. This was followed by the social and economic benefits of minimising cost and maximising financial return. The result could lead to a greater demand for future sustainable development of residential properties, and future investment.

Keywords: Green Building, Green Residential Buildings, Homebuyers, Motivation

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INTRODUCTION

Green buildings focus on three main uses of energy, water and material to increase the efficiency of resources and reduce the building's impact on the health and environment. Green buildings, particularly in residential property sales, have experienced growth in house ownership based on the 2020 property market report. Ajibola et al. (2019) stated that green real estate investment is poised for persistent growth in the coming years and is supported by the increasing trend of certified green building projects. Locally, 389 green building projects have achieved Green Building Index (GBI) certification in the construction sector with 13 green residential townships (PropertyGuru, 2021). A green or sustainable township must be designed and built with efficient resources that commonly address environment, social, and economic issues (Green Building Index, 2020). GBI, one of the green rating systems in Malaysia, guides developers to incorporate sustainability elements into their development. Six main criteria need to be fulfilled for a residential building to be certified as green: energy efficiency, indoor environmental quality, sustainable site planning and management, materials and resources, water efficiency, and innovation (Green Building Index, 2020). The increasing trend in local green real estate projects in Malaysia reflects the growing number of ownerships of investor-owned green buildings. This reflects homebuyers' and investors' increased awareness of the importance of sustainability and green residential buildings.

Several studies have recorded the growth in purchasers' demand for green residential buildings in Malaysia since 2012. Chau et al. (2010) revealed that green apartment owners were willing to purchase green real estate for investment purposes with the idea of embracing sustainable development. According to new research, green real estate has considerable benefits to building occupiers (Zhang & Dong, 2010), such as attention restoration, health improvement, reduced maintenance cost and utility consumption, as well as improved indoor air quality. Aman (2014) found that reducing energy and water consumption and using recycled materials were significant drivers in applying the green practice in Malaysia. To acknowledge buildings as green, they must be constructed and maintained with efficient resources that address environment, social, and economic issues (Green Building Index, 2020). Kim et al. (2020) indicated that green real estate is a sustainable building with the efficient use of resources required to reduce building impacts on the environment and well-being. In addition, prioritising efficient energy and water consumption will result in low-carbon or sustainable development.

Despite the abundance of literature on green building concepts, awareness and benefits, past studies have yet to probe the motivations for green real estate investment from the perspective of homebuyers. It is important to determine the motivations for green real estate investment from the purchasers' views, which could lead to a higher demand for green building development.

More projects of green building development will result in low carbon emission development, reducing greenhouse gases that directly will facilitate Malaysia to achieve the 4th strategy thrust of the 11th Malaysia Plan, which is related to green growth, which is pursuing development to be more sustainable. As a corollary, the research aims to bridge that gap in the literature through exploring the key factors for green residential motivations.

LITERATURE REVIEW

Motivation to Go Green

A change in human behaviour from investing in conventional buildings to sustainable buildings refutes the notion of a motivation to go green. Several studies interpret motivation as a notion of human conviction for the performance of a decision or action. The dimensions of motivation could come from an individual acting out of volition or an individual or a group of people's efforts to avoid something negative, as elicited from the self-determination theory (Olanipekun et al., 2018). Various underlying motivations have been found that will influence purchase intention to invest in green real estate, particularly in the residential sector. Zhang et al. (2019) stated that motivation to go green may be persuaded by the benefits of green buildings like energy consumption and restorative indoor environment or concern about environmental impact. Further, Chuweni et al. (2022) found the main factors influencing the green attributes which are location factors followed by financial and neighbourhood as well as housing certification from the Malaysian Green Building Index.

Green Residential Buildings Motivation Variables

Following recent research by Chuweni, Saraf, & Fauzi (2022) four variables have been identified as motivation variables for property buyers or investor-owned green residential properties. These variables concern environmental degradation, financial returns, cost-saving, and social and environmental benefits. While research by Kim et al. (2020) has revealed that investor-owned certified green buildings have tendencies that benefit the environment. Environmental concerns change an individual's purchase intent. The intensification of climate change awareness and rising energy costs have also increased the market attractiveness for green buildings (Xiao & Yuan, 2017). One of them includes renewable energy since the exploration of new renewable energy will contribute significantly to less dependency on non-renewable energy (Omer, 2014) and it can reduce the impact on the environment (Balramdas et al., 2016; Roper & Beard, 2009). Another element is reducing environmental pollution due to sustainability involvement since it commonly aims to reduce co2 emissions (Razali, 2018) and adverse environmental impacts (Shaikh et al., 2019).

Environmental benefits from green buildings have indirectly affected the social motivation of the building users, particularly on health benefits. The health benefits are good indoor air quality, stress reduction, attention restoration and building user productivity. In other aspects of social benefits, green buildings provide more green space. Besides contributing to reducing carbon emissions, these buildings offer a more significant buffer zone (Kim et al., 2020).

Meanwhile, prevalent studies on sustainable development find that economic aspects contribute to green real estate motivation for construction and investment purposes. For instance, minimising the cost factor is recognised as one of the main motivations for green real estate investment (Ajibola et al., 2019; Deng & Wu, 2013; Kim et al., 2020). Research by Mangialardo et al. (2019) revealed that green buildings could save ⅓ of the total energy consumption. Integrating green technology into air conditioning reduces energy consumption by 10% to 15% (Fan & Zhou, 2019). Additionally, (Gluszak et al. (2019) highlighted that one of the drivers for the increase in the demand for sustainable buildings is lower operating costs and energy consumption. Besides, with energy-efficient and water-efficient elements in a building, residents can reduce their utility bills, especially energy costs (Chau et al., 2010).

Further, another aspect of economics revealed by Fauzi et al. (2021) is the maximising value factors. Various studies in green building projects, especially commercial and mixed development, have shown that green buildings have higher rents, high demands, and maintain good occupancy status than non-green buildings. The returns come from rents and lower operating costs. Evidence shows that financial returns are influenced by the level of green certification (Chen et al., 2019; Mangialardo et al., 2019). The higher the level of green certification, the higher the returns on investment. In a nutshell, investors and investors-owned show motivation in financial returns to purchase or invest in green buildings. Supply and demand for green real estate have been expanding over the years due to the frequent emphasis by the government and environmentalists on the adverse impacts of uncontrolled development in the construction industry.

RESEARCH METHODOLOGY

This study applied quantitative research methods, and data was gathered from an online questionnaire through email, *Facebook* private groups and *WhatsApp*. The web-based survey allows flexibility and coverage to wider respondents (Evans & Mathur, 2005). The questionnaire has performed comprehension validity and amended according to the academician acceptance of the designated questions. A reliability test of Cronbach's Alpha (α) was conducted to ensure the reliability of the constructs. The items were highly reliable, with a 0.90 reliability coefficient value (Bolarinwa, 2015).

Data Collection

This study applied quantitative research methods, and data was gathered from an online questionnaire through email, Facebook private groups and WhatsApp. The web-based survey allows flexibility and coverage to wider respondents (Evans & Mathur, 2005). The questionnaire has performed a comprehension validity and amended according to the academician acceptance of the designated questions. A reliability test of Cronbach's Alpha (α) was conducted to ensure the reliability of the constructs. The items were highly reliable, with a 0.90 reliability coefficient value (Bolarinwa, 2015).

Data is collected from greenhouse residents using a judgmental sampling in Penang and Selangor, Malaysia, particularly certified green residential schemes, namely Ashton of Eco Horizon; Bandar Rimbayu; Residence of Ken Rimba; and Eco Majestic. The selected residential schemes are chosen as case studies as they received green certification from GBI. To determine the optimum number of sample sizes, the researcher used the rule of thumb 5:1 ratio as suggested by Hair et al. (2010), of which five responses should be obtained for each variable. The total numbers of items were 23; hence, the required sample size was supposed to be at least 115 (23 x 5). Therefore, a sample of 171 respondents was sufficient to analyse the data. Respondents received a Google form link that contained the questionnaire. In this survey, respondents were asked to rate how agreeable they were with the items on a five-point Likert scale, ranging from 1 for "strongly disagree" to 5 for "strongly agree". The five Likert scale is commonly used in research where the midpoint in the five Likert scale usually represents neutrality to avoid coercion in giving a choice of response (Youn et al., 2017).

Data Analysis

The data collected from the online questionnaire were analysed descriptively, and the relative importance index (RII) was used to assess and rank the attributes towards the motivation to invest in green residential properties. As cited in Rooshdia et al. (2018), five important levels are transformed from important values. They begin with high (H) ($0.8 \leq RI \leq 1$), high medium (H–M) ($0.6 \leq RI \leq 0.8$), medium (M) ($0.4 \leq RI \leq 0.6$), medium-low (M-L) ($0.2 \leq RI \leq 0.4$) and low (L) ($0 \leq RI \leq 0.2$). The highest ranking refers to the highest RI value. Waidyasekara & Silva (2016) also mentioned that a low RII indicates that the factor is less applicable and less relevant, whereas a high index indicates higher applicability, agreement, and relevance.

RESULTS AND DISCUSSION

There are four main elements of the results, namely 1) environment, 2) social, 3) economic (maximising value) and 4) economic (minimising cost). Table 1 depicts the overall ranking and importance of each attribute towards the motivation of the greenhouse. Based on the RII score, all attributes were found to be at a high level when RII scores were found to be more than 0.8.

Table 1: Motivation for green residential investment

Motivation Element	RII	Rank	Importance Level
Environmental Concern	0.9233	1	High
Social Benefits	0.9073	2	High
Economic (Minimising Cost)	0.9064	3	High
Economic (Financial Returns)	0.8816	4	High

The researcher found that environmental concern ranked first (RII=0.9233), followed by social benefits (RII=0.9073), economic benefits of minimising cost (RII = 0.9064), and economic benefits of maximising financial returns (RII=0.8816). These revealed that the main motivation for green residential investment is due to the environmental concern as found in Rameezdeen et al. (2019), while at the same time, the residents can improve their social lifestyle and contribute to economic sustainability. In other words, our result indicates that sustainability goals of environmental concerns are the main motivation for greenhouse residents or owners to purchase green certification residential properties investment in Malaysia. Similar results were found when Chau et al. (2010) revealed that green apartment owners were willing to purchase green real estate for investment purposes with the idea of embracing sustainable development.

Table 2: Environmental benefits

Environment	RII	Rank	RII Group
Reduce dependence on non-renewable energy	0.9345	1	
Reduce pollution to the environment	0.9287	2	
Reduce the global warming problem	0.9205	3	0.9233
Can provide clean air to the occupants	0.9193	4	
Increase opportunities for environmental control	0.9135	5	

Table 2 further shows the RII score for environmental concerns for green residential investment. Results indicate that environmental concern attributes, particularly the usage of solar energy provided in green residential properties, could reduce the dependence on non-renewable energy. Other attributes such as reducing pollution to the environment, reducing the global warming problem, providing clean air to the occupants and increasing opportunities for environmental control are important for the motivation of green residential investment. These correspond with the findings from Kim et al. (2020); Omer (2014), who found that green real estate as a sustainable building with the efficient use of resources would likely reduce building impacts on the environment. Therefore, the building should be developed to reduce pollution to the environment. A global warming problem reduction element is equally significant by which the building development has to incorporate zero CFC equipment that directly contributes to reducing ozone depletion and global warming issues (Balramdas et al., 2016).

Table 3: Social benefits

Social Benefits	RII	Rank	RII Group
Maintain the temperature and supply fresh air	0.9146	1	
Control the flow of temperature, airflow and humidity in the building	0.9123	2	
Indoor environmental quality	0.9111	3	
Filter and reduce noise interference	0.9064	4	0.9073
Improve health condition	0.9064	5	
External green view	0.9064	6	
Interacting with nature	0.9041	7	
Reduce chemical exposure to the occupants	0.8971	8	

Regarding social benefit, the highest RII score (RII=0.9146) was found in greenery attributes, particularly the plants planted around the residential areas as well as in their greenhouse that can maintain the temperature and provide fresh air as in Table 3. This is in line with a study by Nizarudin et al. (2011), which determined that natural resources and landscaping are important and should remain untouched to preserve a sustainable environment. Oyewole et al. (2019), agreed that those landscaping and landscape ecology elements should be considered for sustainable buildings, as these contribute to natural, healthy oxygen supply and scenery to the occupants in that building. Social attributes such as indoor air, environmental quality, and health improvement are found to be at a high level of importance. Our findings were corroborated by Zhang and Dong (2020), who stated that green real estate has considerable benefits to building occupiers, such as attention restoration, health improvement, and improved indoor air quality. Taylor (2013) also indicated that occupant comfort and health are some of the benefits of sustainability. Furthermore, communities also benefit from health enhancement, quality of life and well-being improvements, and occupant comfort (Gou & Ma, 2019; Shurrab et al., 2019).

Table 4: Economic minimising cost

Economic: Minimising Cost	RII	Rank	RII Group
Reduce the electricity consumption from optimal penetration of natural light	0.9099	1	
Reduce utility costs through solar energy installation	0.9088	2	

Reduce electricity costs through energy-saving electrical appliances	0.9076	3	0.9064
Contribute to the efficient use of energy resources	0.9064	4	
Reduce the water consumption cost	0.9029	5	
Reduce the use of air conditioning system	0.9029	6	

For economic benefit, following Fauzi et al. (2021), (2020), the researchers applied breakdown analysis in which the data were divided into two categories for a more robust result. Economic benefits for motivation to invest in green real estate investment, particularly the greenhouse, are likely due to cost-saving motivation or maximisation of financial return in the future. Table 4 illustrates the ranking of economic benefits of minimising the cost. It is apparent from the results that green residential design could reduce the electricity consumption cost due to the optimal penetration of natural light with an RII score of 0.9099. The results of cost saving in Table 4 are also in line with previous research when minimising the cost could be likely considered as one of the main motivations for economic benefits in investing in green real estate (Ajibola et al., 2019; Deng & Wu, 2013; Kim et al., 2020; Mohd Adnan et al., 2017).

Table 5: Economic benefits: maximising financial return

Economic (Maximising Financial Return)	RII	Rank	RII Group
Enjoy lower financing from the bank	0.9181	1	
Will be in higher demand in the future	0.9099	2	0.8816
Provide higher market value in the future	0.8994	3	
Guarantee higher rental returns in the future	0.7988	4	

The result of the RII score for economic benefits in terms of maximising the return is depicted in Table 5. Evidence shows that financial returns are influenced by the level of green certification (Chen et al., 2019; Mangialardo et al., 2019). It was found in this study that the highest RII score (RII = 0.9181) was when the respondents were eligible to enjoy lower financing from the bank with the purchase of their green residential properties. This was followed by the higher demand anticipated in the future for green residential properties (RII=0.9099) and an appreciation in value for capital or market value (RII=0.8994). Interestingly, the attribute of higher rental value was found to be at a high-medium level of importance when it produced the lowest RII score not only for economic benefits but also for overall attributes (RII=0.7988). This shows that having a green certification for residential properties is perceived by the respondents as unable to guarantee higher rental returns in the future.

CONCLUSION

Based on the overall RII score, all three dimensions of environment, social and economic benefits were found to be the top attributes for these motivations, implying the importance of these three sustainability goals to be adopted in future residential development. The data is collected through a survey by distributing questionnaires to selected green residential owners or residents in Malaysia, particularly the residential scheme which received green certification. The relative importance index is applied to data from 171 respondents through a judgemental sampling. Environmental concerns were ranked as the main motivation in influencing the green homebuyers' decisions, followed by social and economic benefits (minimising cost and maximising financial return). These three dimensions of environment, social and economic benefits imply the significance of sustainability goals for future residential development. An informed decision on the benefits received, especially for green residential properties, could affect the resident's motivation towards purchasing certified residential properties, encouraging more demand for green development in the future.

By addressing the importance of sustainability implementation, this study establishes the need for the stakeholders and policymakers to promote environmental practices while contributing to the economic and social development of more green residential schemes. For the property development industry, specifically for green residential building development, this study could provide the best indicator for buyers' motivation which could be embedded in their development. For instance, we found that the main environmental benefit of investing in green residential properties is to reduce dependence on non-renewable energy. This could be done by selecting materials, processes, design, and construction of these green residential properties. Moreover, this research intends to facilitate related parties and organisations to provide appropriate incentives, recognition and take the correct action to increase the investors' and buyers' awareness of green residential buildings. Further development of empirical models could be developed and tested in other countries and on other types of green buildings. This could further facilitate more interest in green and sustainable residential property development and investment in the future.

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LOW-COST STRATA MAINTENANCE ISSUES AND COST IMPACT

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Abstract

The economic and social developments in Malaysia have encouraged internal migration of locals from rural to urban areas, in response to this migration, the government initiates high-rise developments for housing to fulfil these movements. Maintenance work practices aims to benefit the building's operational age. Maintenance includes all building elements including the façade, flooring, plumbing, electrical and structural maintenance. The aim of this study is to identify the most common maintenance issue that occurred and reported within selected strata schemes. The objective is to identify maintenance issues as reported and observed by strata management bodies and which have the highest cost impact according to the management bodies. A survey involving 50 strata management bodies within the Klang Valley amongst low and medium low-cost strata schemes were conducted and analysed. The result shows that the top three most common maintenance issues are clogged plumbing roofing structure, leakage, and sewer pipe maintenance whilst maintenance with highest cost impacts are relating to general repair, maintenance works and general electrical supply maintenance. Other problems include small but repetitive repairs such as corridor lightings, drainage clogging, leakages and other works that generally affect the residents' use and enjoyment of the common properties.

Keyword: residential strata, strata management, maintenance issue, cost impact

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INTRODUCTION

The economic and social developments in Malaysia have encouraged internal migration of locals from rural to urban areas, in response to this migration, the government initiates high-rise developments for housing to fulfil these movements. This strata concept was introduced in the National Land Code 1965 (NLC/KTN) in accordance to a referred model of the New South Wales Conveyancing (Strata Titles) Act 1961, Australia. The strata ownership concept allows scattered ownership in respect to accessory parcels, phases and division and unification of parcels, which however was not included under the NLC's provisions, but was later included under the Strata Titles Act 1985.

As of 2017, after 32 years of enforcement of Strata Titles Act 1985, a total of 1,282,156 strata titles were registered throughout the Peninsular of Malaysia. This is an increased record in comparison to after 4 years of STA enforcements of only 20,000 registered strata titles. This increase shows the significance of having a well-developed strata law to ensure efficient transactions of strata properties indirectly resulting to increase the national income potential through stamp duty, parcel and assessment taxes.

LITERATURE REVIEW

Common Facilities

The increasing number of purchasers opting to own strata properties; thus, it is equally important for the strata owners and tenants to understand the difference between a shared facility, ancillary parcels and outside of strata schemes. Distinguishing between these elements is crucial in identifying which facility and amenities fall under the responsibilities of the strata owners and which falls under the responsibilities of the strata management bodies.

There are 3 elements to a strata scheme, namely the common property, the parcel and the outside of strata scheme. The main focused element for this study is the common property, consisting items like the roof, water tank, gutter, rainwater down pipe, external wall. Sewer pipe, apron and drainage, common use window, retaining wall, playground, fence, sewer pipe, manhole, garbage house, prayer hall, hall, lift, staircase and corridor. The table below shows the simplified illustration that differentiates between the 3 strata elements.

Table 1: Elements of strata building

Common property
(i) Roof leakage (ii) Water tank leakage (iii) Gutter leakage (iv) Rainwater down pipe leakage (v) External Wall damages (crack, painting, etc) (vi) Sewer pipe leakage

(vii)	Crack on apron / drainage
(viii)	Common use window
(ix)	Retaining wall
(x)	Playground
(xi)	Fence
(xii)	Sewer pipe
(xiii)	Manhole
(xiv)	Garbage house / hall and prayer hall
(xv)	Lift
(xvi)	Staircase & Corridor
Parcel	
(i)	Internal Wall damages (crack, painting, etc)
(ii)	Floor leakage
(iii)	Pipe leakage / clogged
(iv)	Units' window
Outside of Strata Scheme	
(i)	Outside the compound fences
(ii)	External Slopes
	Items in this element is under the maintenance and management of the local authority or the related service provider

Source: Infographic KPKT (n.d)

Building Maintenance

Maintenance is a practice that is performed to benefit the building's life cycle and an attempt to prolong the building's operational age. Building maintenance is defined as the combination of technical and administrative actions, inclusive of supervisions, and actions to perform maintenance works. Maintenance works can either be a repair, prevention and replacement works, whichever is necessary for the facilities to be in an acceptable operational condition within minimum and / or efficient cost (Jaini et al., 2022; Zawawi et al., 2016).

Facilities maintenance includes all building elements like the facades, flooring, plumbing, electrical and structural maintenance. In other words, maintenance and repair works are inclusive of works that include reasonable measure to ensure and/or improve the use and enjoyment of strata owners, to remove any nuisance, as well as ensuring that the properties are in good state and serviceable repair. An efficient maintenance management involves strategic planning by the management body and each corporation would commonly have an established own management procedure to ensure overall cost efficiency and well-planned maintenance works. Each maintenance involves the following components (El-Haram & Horner, 2002; Jaini et al., 2022):

I. General management
II. Staff management

III. Financial management
IV. Contractor
V. Technical and technology
VI. Building
VII. Awareness

The above components contribute to the overall budget planning for maintenance works. Hence strategic information storing and budget allocation for maintenance resources are extremely important especially with the knowledge on maintenance works with higher cost impacts as well as its repair and maintenance frequencies.

The core function of the strata managing bodies, i.e., the Joint Management Body (JMB) and Management Committee (MC) comprises to maintain and manage facilities and amenities especially the common shared properties (KPKT, 2020). Maintaining property incorporates technical and administrative activities towards maintaining and restoring the original condition of the building, ensuring that all building components inclusive of the structure, function and aesthetics are equally taken care of (Kampamba et al., 2020).

Quality records can prevent misplacement and loss of records especially for managers that confirm manual record keeping. The COB's effort to transit from manual system to an electronic or computerized benefitted both the COB in monitoring the management bodies activities as well as easing the management bodies, record keeping, which will also improve the data reliability (Norolazmi et al., 2018).

Issues in strata maintenance

According to another study done on strata management, it was concluded that enforcement actions taken against defaulters are related to matters of finance, either due sum of maintenance fee or failure to contribute to sinking funds. The following table shows the summarised enforcements taken:

Table 2: Summary of enforcements taken between 2017 to 2020

	Description / Offences	Number of Cases
1	Procedure **on recovery of sums due**	22,862
2	Failure to comply to services of any person or agent to maintain and manage common property	4,151
3	Strata Roll	1,229
4	Criminal penalty for failure to comply with award	652
5	Duties and powers of developer during developer's management period	545
6	Parcel owners to pay Charges and contribution to the sinking fund	500

	Description / Offences	Number of Cases
7	Failure of developer to convene first annual general meeting of joint management body	175
8	Failure to comply to duties of joint management body in relation to accounts	131
	Total	**30,245**

Source: (Ainul Ashiqin et al., 2022)

The poor collection of maintenance fee influences the management body's ability to procure resources. Poor fee collection causes shortage of financial resources especially in resourcing for skilled personnel for administrative purpose, as well as technical works for labour, material and equipment (Kampamba et al., 2020). Fee collection significantly affects the overall maintenance and management budgeting in delivering efficient building maintenance, consequently reduces prolonged budget shortages, constraints and cost overruns (Gala Mong et al., 2018).

Other than issues in financial resources, other top three most critical issues in maintaining and managing high-rise residential building are; (i) managing expectations of strata owners to JMB is more complex and challenging; (ii) managing bodies' difficulties in getting support from strata owners; and (iii) poorly planned future maintenance (Abas et al., 2021). Managing expectations can be seen through the strata owners' / tenants' satisfaction level towards the overall maintenance and management which is often hard to satisfy. Whilst having high expectations, strata management bodies simultaneously have difficulties in receiving the support from residents, either through contribution of maintenance fee or attendance in annual general meetings.

Similarly, conclusions from the said study are further supported in another study conducted by Noor Suzilawati et al., (2021), Table 3 and Wahi et al. (2018), Table 4, both studies showing consistencies between the damage frequencies and satisfaction level on maintenance of related facilities.

Table 3: RII Frequency of damages

Types	**Rank (RII value)**
Vandalism	1 (0.910)
Water tank leaking	2 (0.905)
Pipes leaking or clogged	3 (0.900)
Damages to surau /hall	4 (0.890)
Roof leaks	4 (0.890)
Clogged manholes	5 (0.885)
Poor garbage houses	6 (0.875)
Clogged rainwater down pipes	7 (0.860)
Poorly maintained or damaged playgrounds	7 (0.860)

Clogged perimeter drains	8 (0.855)
Cracks in wall	8 (0.855)
Between floor/wall leaks.	9 (0.840)

Source: Noor Suzilawati et al. (2021)

Table 4 Satisfaction level on high rise low cost housing issues

Types	**Rank (RII value)**
Roof leakage	1 (0.742)
Criminal cases	2 (0.702)
Noise	3 (0.586)
Corridor lighting	4 (0.559)
Drainage system	5 (0.531)
Internal ventilation	6 (0.479)
Fire door	7 (0.459)
Corridor spaces	8 (0.452)
Staircase condition	9 (0.444)
Safety walking under uncovered corridor	10 (0.418)
Material quality	11 (0.403)
House design	12 (0.398)
Plumbing system	13 (0.384)
House workmanship	14 (0.381)
Handicap facilities	15 (0.365)
Lift numbers	16 (0.354)
Lift size	17 (0.352)
Lift maintenance	18 (0.342)

Source: (Wahi et al., 2018)

Whilst the study in Table 3 and Table 4 shows a different set of maintenance elements, some items or elements are considered common. Though different terms were used between the two studies, criminal cases and vandalism, roof leaks, and drainage systems showed significance (high RII value) in both studies.

Aside from poorly planned maintenance or generally poor support from the residents, another contributing issue resides even before the building's occupancy with operating management bodies that is during the planning and the construction period. This would explain the initial quality of the facilities provided that results in frequencies of damages and the future incurred maintenance cost. Developers inclusive the design and construction team should be actively involved during the construction stage starting from the pre planning, design until the construction as their input and experience has great influence on the overall building quality, subsequently affecting the building's life cycle cost (Abas et al., 2021; Kampamba et al., 2020). Such involvement should be able to improve documentation and to reduce issues for management bodies to plan more strategic maintenance plannings with the support of full details on the facilities and warranties provided. Lateef (2009) has further suggested that a value-based maintenance management can significantly be improved through controlled construction quality. This study will further investigate the most common maintenance issue and which maintenance and repair work has the most cost impacts.

RESEARCH METHODOLOGY

This paper is based on strata managements' experiences in managing and maintaining strata properties. The survey was distributed via online and face to face survey sessions with representatives of 50 management bodies involving 50 strata low and low-medium cost strata schemes within the Klang valley area. The strata management were enquired on the most frequent maintenance issues regarding the common facilities within their respective strata schemes. based on the itemised maintenance works, the management bodies were also enquired on which of the maintenance works incurred the higher cost by comparison.

ANALYSIS AND DISCUSSION

Responses from 50 representatives of strata management bodies were analysed. Table 5 shows the distribution of respondents involved in this study.

Table 5: Management Bodies' Background

Variables	Components	Percentage (%)
Management Body	Joint Management Body (JMB)	48%
	Management Committee (MC)	50%
	Managing Agent	2%
Local Authority	MB Kajang	21
	MB Shah Alam	12
	MB Petaling	17
Type of Strata Scheme	Low Cost	31
	Low Medium Cost	19
No.of Blocks	1-5 Blocks	44
	6-10 Blocks	4
	10> Blocks	2
No. of Units	1-200 Units	30
	201 – 400 Units	9
	401 – 600 Units	8
	601 – 800 Units	2
	801 > Units	1
No.of Lifts	No Lifts	37

Variables	Components	Percentage (%)
	1-4 Lifts	11
	5> Lifts	2

Source: Author (2022)

The respondents were questioned on the frequencies of repair and maintenance works on elements in shared strata properties in the questionnaire form. Based on the responses given, between least frequent to most frequent, the Relative Importance Index (RII) was calculated and the results are shown in the table below.

Table 6: Items requiring most frequent to least repairs and maintenance works using RII (According to Management Bodies)

Item	RII	Rank
Clogged Plumbing	0.745	1
Roofing	0.715	2
Sewer Pipe	0.705	3
Manhole	0.700	4
Leakage	0.665	5
General Drainage	0.615	6
Vandalism	0.595	7
Rainwater down pipe	0.580	8
Unit windows	0.390	9
Compound Fencing	0.360	10

Source: Author (2022)

Fifteen (10) elements of shared properties were included as variables according to KPKT's classification of shared strata properties. Based on the result, the highest RII score is 0,745 which is the clogged plumbing, second highest relates to repair and roofing maintenance at RII value of 0.715 and the third highest RII value is 0.705 that is repair and maintenance for sewer pipe. On the bright side, it can be primarily concluded that the strata compound safety is at an acceptable state as they require least repair, which shows minimal to zero break-ins or damages, on both compound fencing and unit windows at RII Further of 0.390 and 0.360 respectively.

Further to the above question, the respondents (management bodies) were questioned on which of the maintenance works has the highest cost impact by comparison. The respondents were asked to evaluate within scale of 1=least cost to 4=highest cost. The result of the question is presented in the following table.

Table 7: Cost impact on Maintenance and Management using RII (According to management bodies)

Maintenance work	RII	Rank
General repair and maintenance work	0.850	1
General Electrical Supply	0.820	2
Management Office Costs	0.810	3
Auditing Fee	0.805	4
Staffing	0.800	5
Electrical system Maintenance	0.795	6
Waste management	0.780	7
Sewage System	0.760	8
Cleaning Service	0.755	9
Maintenance of Fire Fighting System	0.750	10
Information Board / Signage	0.700	11
Parking Space	0.665	12
Landscape Area	0.600	13
Security Body	0.590	14
Elevator	0.575	15
Air Conditioning System	0.495	16

Source: Author (2022)

Maintenance work with the highest cost impact are the general repair and maintenance works (RII = 0.850), this includes works that has immediate effects towards the residents' use and/or enjoyment throughout their strata dwelling. Secondly is the general electrical supply works (RII = 0.820) that includes corridor and staircase lightings, common properties' electrical outlet plugs. The third highest maintenance incurred cost (RII,= 0.810) is regarding maintaining the operation of the management office. Maintaining the management office consists of matters of both direct and indirect costs, hence justifies the cost incurred in maintaining the management office.

The result in Table 7 also indicates maintenance work that has the least cost significance are maintenance of air-conditioner (RII = 0.495), and Elevator maintenance (RII = 0.575). The result for elevator maintenance is on lower RII due to the majority of the responses being from low-cost strata without elevators provided within the strata schemes. Similarly, most low-cost strata schemes do not provide air conditioning in the common facilities, hence explains the contrast the commonly reported, elevators being one of the most critical maintenance issues, due to its cost.

CONCLUSION

The results of this study consistent with studies that shows one of the most critical and common maintenance issue is relating to plumbing and clogging issues, though it may contrast from another study that shows lifts maintenance as critical issue, the same scenario cannot be imposed on this study as majority of the respondents came from strata schemes without elevator / lifts services, hence similar issue is out of the question.

Based on this study, it can also be concluded that small but repetitive repairs and maintenance has significant cost implications towards cost of maintenance. General repairs the likes of repairing damages caused by vandalism, poor lighting quality, inclusive of common repairs relating to overall use and enjoyment of the strata residents, cumulatively has significant cost impact in maintaining and managing strata properties. Small but repetitive repairs and maintenance is also a result of poor maintenance planning on the management's side. Well documented information, construction and product details plays a significant role in ensuring strategic maintenance plannings. Such documentation and information storing starts from the involvement of related professionals from the design until the construction stage, to ensure the quality of constructed and installed facilities and tools are to code and are able to result in efficient life cycle cost as well as to prolong the building's life span as a whole. COB playing its role in ensuring that the strata management bodies (JMB / MC / Managing agents) to play their roles in efficient management and maintenance of the strata properties goes a long way, especially at the current growth rate of residential strata properties.

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DETERMINING THE INTERVENTION STRATEGY FOR HERITAGE SHOPHOUSE FACADES AT IPOH, PERAK

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Abstract

Nowadays, there are a large number of heritages shophouses remain intact in the major urban area in Malaysia, including Ipoh, Perak. However, some of the shophouses are facing inappropriate façade changes due to improper actions committed against the heritage property. The situation resulted in the phenomenon of inconsistency elements of building facades. This paper focuses on two aspects; first, identifying the improper actions committed against heritage shophouse facades compared to proper conservation approaches, and second, classifying the condition of the heritage shophouse facades to determine the current problems and dilemmas. From the literature review, five terms of improper actions are relevant; refurbishment, replacement, redesign, alteration, and deterioration. A pilot test involved twelve shophouses have been selected via purposive sampling. The results show that the terms are reliable to classify the condition of the shophouse facades. Most of the samples encounter dilemmas, mainly replacement and deterioration of the elements of the façade. The terms are also seen as relevant for a future heritage shophouse grading system for inventory purposes. The research findings may promote greater awareness among the owners, stakeholders, and the local authority on the prevailing situation experienced by the heritage shophouses.

Keywords: Heritage shophouse, façade, improper actions, conservation

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INTRODUCTION

Heritage buildings are synonymous with the history of the development and growth of several major cities in Malaysia. These buildings have been built since the 1600s in Malacca, late 1700s in Penang, and the early 1800s in Ipoh (Fee, 2008). The three cities have been through colonisation eras that have influenced the building characters and architectural landscape. For decades, most heritage buildings that are integrated with the Malay, Chinese and European styles (Mohd Jaki & Muhammad Firzan, 2020) are still occupied and remain in their original form and design. It conveys cultural heritage significance, which means a building possessing architectural, aesthetic, archaeological, historical, scientific, social, or cultural values (National Heritage Act 2005, 2012; Tan et al., 2016).

Conservation means the process of understanding, safeguarding, and protecting from being destroyed or changed in an inappropriate manner (Fielden, 2003). Therefore, in maintaining the integrity of heritage buildings, the selection of conservation approaches is crucial to meet the current condition of the buildings that include prevention, consolidation, restoration, rehabilitation, reproduction, preservation, reconstruction, adaptive reuse, and maintenance (Department of National Heritage, 2016). Other than that, conserving heritage buildings demands determination and dedication to preserve their cultural, historical and architectural significance (Nur Shahirah & Junainah, 2021). The procedure embraces all acts that extend the life and basic functions (Arazi et al., 2010; Fielden, 2003) of the buildings by providing maintenance, repair, restore (Orbasli, 2008; A Ghafar, 1997). Curl (2006) added that, in complying with the conservation principles, the building characters or details are supposed not to be altered or destroyed, even though repairs or changes may be necessary. In other words, these changes should be managed dynamically, which only involves minimal intervention (Fielden, 2003). According to Siti Norlizaiha (2011), the design and materials that include the architectural styles and construction techniques are the most authentic criterion to be prioritised as they brought together the history of the past evidence of knowledge, ideas and the golden era of the heritage buildings. Thus, there is a need to refer to a complete and standard data regarding the architectural styles and materials to maintain the original design of the heritage buildings (Wan Nordiana & A Ghafar, 2021a).

However, the heritage shophouse is facing a dilemma in preserving its integrity due to several factors. There is an increasing number of interventions on the elements of building façades (Toong, 2015) that ignore the architectural characteristics (Noorfadhilah & Shamzani, 2012; Tan, 2014; Shuhana et al., 2012, Pheng, 2014; Nur Farhana et al., 2017) due to improper actions taken against the façade, thus, creates a phenomenon of inconsistent elements that lead to visual problems. This situation gave negative impact on the architectural styles, characters and historical images of the city (Omar & Muna, 2016; Toong, 2015;

Amir Hossien & Kamariah, 2009; Zalina & Rodzyah, 2012; Elnokaly & Wong, 2014) and eventually will lose their sense of place (Nur Raqena et al., 2020).

The question is, what are the terms for the activities that can be used to classify the improper actions? And what are the parameters for classifying the current condition of the heritage shophouse facades? To ensure that the heritage buildings are well preserved and minimise the occurrence of inconsistent elements of the heritage shophouse facade, precise and clear information about the façade's current situation should be recorded. A set of specific terms for classification or grading purposes is, therefore, need to be developed. The terms are useful as references to the stakeholders for various reasons, such as applying for planning permission, inventory, documentation or conservation. While development and modernisation are necessary, there is a need for a comprehensive conservation management plan for heritage buildings (Wan Nordiana & A Ghafar, 2021b).

RESEARCH BACKGROUND

Ipoh is the capital city and the administrative centre for the state of Perak Darul Ridzuan. It is located in the North of Peninsular Malaysia, approximately 200 km from Kuala Lumpur. The city began in 1874 with approximately 100 units of attap houses and a small market. However, in 1892, a great fire broke out and destroyed most of the houses (Hin et al., 2013; Sinnadurai, 2006). The town then was rebuilt with brick buildings in a more systematic grid system for roads and shophouses. The rapid growth of the mining industry has led Ipoh to be the most productive tin ore field in the country and reached its glory in the 1950s. At the 1970s, the economy of the tin-mining industry of pricing collapse, and the city's growth stagnated tin mines were brought to a close. In 1988, Ipoh was granted city status by the Sultan of Perak (Zulqarnain, 2017). On 18th December 2014 due to the provision of the Town and Country Planning Act (Act 172), the heritage area of Ipoh City consists of Core Zone (79.70 hectares) and Buffer Zone (175.50 hectares) has been gazetted. The uniqueness of the city is the architectural asset, which includes 1,022 shophouses that reflect a variety of styles from the early 80s to the 90s (Ipoh City Council, 2014). Apart from its unique heritage shophouses, Zulqarnain (2017) highlighted that Ipoh is a fascinating city and has received several global recognitions, including 9th Best City to Retire in the World 2013, 6th Best Destination in Asia 2016, 9th Best Tourism Region 2017 and others.

LITERATURE REVIEW

Heritage shophouse

The shophouse is usually listed in the category of mixed-use and commercial. Due to its double function as residential on the upper floor and business at the ground floor, the shophouse is more appropriate to be under the mixed-used category (Gurstein, 1990). Nowadays, the heritage shophouse that is no longer occupied for residence is categorised for commercial use. This long-narrow building consists of a façade, commercial area, air-well, dining area, kitchen, and bedroom on the upper floor. The most significant element is the front façade as a medium to convey the design era when it was built and the building's function. A Shophouse façade is defined as 'a building element facing the street consisting of structural, enclosure, opening, fenestration and ornamentation' (Burden, 1996, 2004; Wooi, 2015; Hopkins, 2013; Curl, 2006; Harris, 1983; Ahmad Sanusi and Shaiful Rizal, 2012; Wan Nordiana & A Ghafar, 2022). By referring to the definition, five main elements of the façade will be focused on determining the condition of the façade.

Intervention and improper actions

Intervention is rapidly increasing, which threatens the survival of the heritage buildings. Breslin (2016) defines intervention as involving oneself in a situation, mainly to prevent conflict. However, in heritage buildings, intervention means what is done to the building (Tyler, 2000). The 'something done' to the building is the treatment strategy and represents an appropriate intervention situation. Interventions practically always involve some loss of a 'value' in cultural property but are justified to preserve the objects for the future. According to Fielden (2003), the various scales and levels of intervention intensity are determined by the physical condition, causes of deterioration, and anticipated future environment of the cultural property under treatment. The seven ascending degrees of intervention are (1) prevention of deterioration; (2) preservation of the existing state; (3) consolidation of the fabric; (4) restoration; (5) rehabilitation; (6) reproduction; and (7) reconstruction.

The intervention may cause some changes to a place that should be guided by the cultural significance of the place and its appropriate interpretation (UNESCO, 2005). The change that reduces the value of cultural significance is likely due to improper actions committed against the heritage property. The improper actions refer to terms or approaches that do not comply with the conservation principles, as shown in Figure 1. The terms can be used to identify the problems and classify the conditions of the heritage shophouse facade.

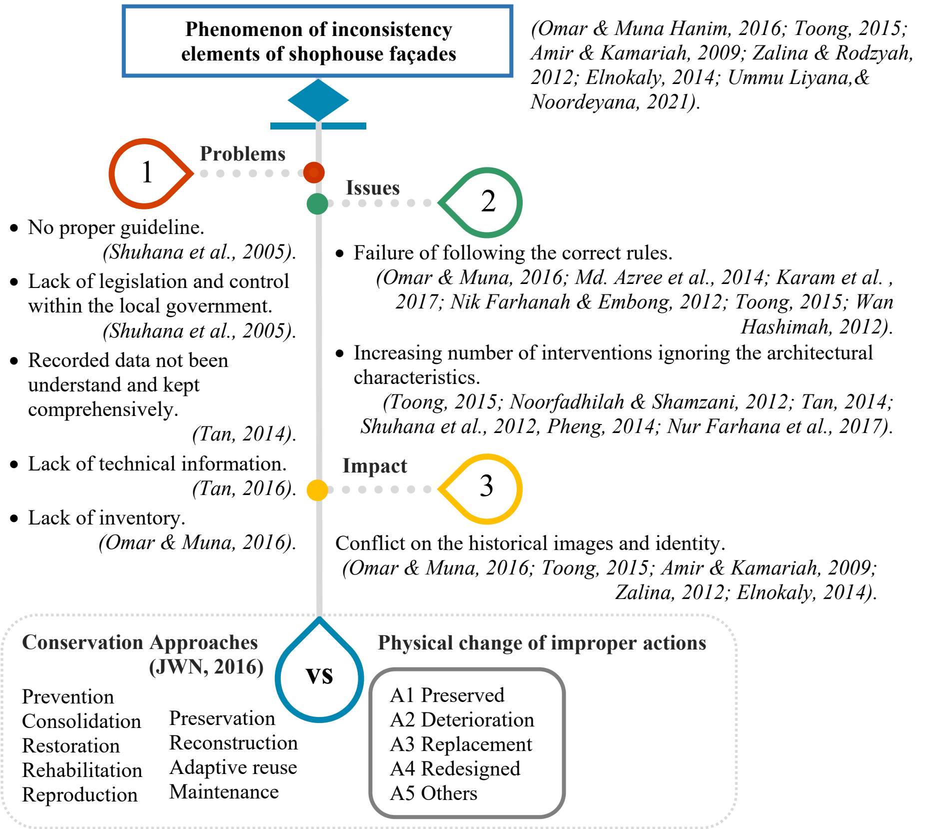


Figure 1: Conservation approaches and improper actions.

The six (6) steps for determining the intervention level of the heritage shophouse facades formulated and adapted from the concept by Zhang and Dong (2019) as illustrated in Table 1:

i. Stakeholders: are the owners, sponsors, governments and non-governmental organisations.
ii. Typology: Types of heritage buildings are heritage shophouses.
iii. Existing fabrics: Physical character of the heritage shophouse facades includes beams, columns, roof, walls, doors, windows, air-vent, fenestration and ornament for Transitional, Eclectic, Neo-Classical, Early Modern and Modern.
iv. Functional change: Determine the preservation of the heritage shophouse facades whether it maintains the original elements, maintains the original elements and adds a little new element or new element.

v. Potential problems: Identify the problems that occurred on the heritage shophouse facades, deterioration, replacement, redesign and others.
vi. Conservation action: Five (5) levels of intervention from minimum up to maximum intervention namely maintenance, rehabilitation, restoration, reconstruction and combination of interventions.

Table 1: An intervention strategy for heritage shophouse facades.

<table>
<tr><th colspan="6">Intervention strategy for heritage shophouse facades at Ipoh, Perak</th></tr>
<tr><td colspan="2">Stakeholders</td><td colspan="4">Owner, sponsor, government and non-government bodies.</td></tr>
<tr><td colspan="2">Typology</td><td colspan="4">Heritage shophouses</td></tr>
<tr><td>Existing fabric</td><td>Physical characters: Beam, column, roof, wall, door, window, air-vent, fenestration and ornament.</td><td colspan="4">
Transitional, Eclectic, Neo-Classical, Art Deco, Early Modern & Modern</td></tr>
<tr><td rowspan="3">Functional change & potential problems</td><td colspan="2">1)Preserving existing elements</td><td>2)Preserving existing elements and adding some new elements</td><td>3)New elements</td><td>Others</td></tr>
<tr><td colspan="5">Potential problems</td></tr>
<tr><td>Preservation
The shape, colour or material of the elements and structures are in an existing state and well maintained.</td><td>Deterioration
The elements and structures are in an existing state but affected by fungus, broken, cracked, rusted, faded or vegetation growth.</td><td>Replacement
Replacing the damaged part of the facade with new elements in existing shape and design.</td><td>Redesign
Changed shape, colour or existing material to a new scheme.</td><td>Others
The elements were hidden by signage or vegetation, demolished, new buildings, in-fill, etc.</td></tr>
<tr><td rowspan="4">Conservation actions</td><td colspan="5">Intervention levels</td></tr>
<tr><td colspan="3">Minimum intervention</td><td colspan="2">Maximum intervention</td></tr>
<tr><td colspan="5">Intervention scales</td></tr>
<tr><td>5
Maintenance & prevention
Repair work, supervision and continuous care to prevent decay or obsolescence without changing the original condition.</td><td>4
Rehabilitation & consolidation
Modernization without changing the original use and adding supports to continue durability.</td><td>3
Restoration
Replacing missing details or restoring the building to match the appearance and original construction materials.</td><td>2
Reconstruction
Rebuild in whole or in part.</td><td>1
Combination
Implement other approaches and actions that comply with heritage building conservation guidelines.</td></tr>
</table>

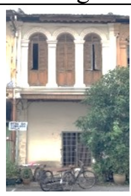
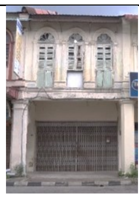
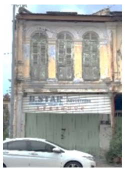
METHODOLOGY

In preparing this research paper, a research framework had been developed. Firstly, problems regarding the architectural scope of heritage shophouses contributing to issues were identified and extracted from articles. The data collection for this research is using multiple methods. Firstly, by reviewing documents to identify the appropriate terms for improper actions committed against the heritage property. Sources of data are from books, dictionaries, and government reports ranging from local to international authors such as Tyler (2000), Fielden (2003), Burden (2003), Orbasli (2008), and Department of National Heritage (2016). The relevant terms were finalised by its definition: replicate, refurbishment, replacement, redesign, alteration, and deterioration. Secondly, fieldwork for the pilot test was conducted. By using purposive sampling, twelve (12) shophouses had been selected. The criteria of the facades were; they were not properly conserved to identify the problems encountered. Assessment is focused on nine (9) parameters that include beam, column, roof, wall, door, window, air vent, fenestration and ornamentation.

FINDING AND DISCUSSIONS

The selected heritage shophouse facades in Ipoh are shown in Table 2 and consist of a few architectural styles such as Transitional, Eclectic, Neo-Classical, Art Deco, Early Modern and Modern. Each is coded from S1 to S12. The improper actions are coded from A1 to A6 (see Table 3). There are nine (9) codes for the element of facades. The codes represent; structural (beam and column), enclosure (roof and external wall), opening (door, window and air vent), fenestration and ornamentation (See Table 4).

Table 2. Heritage shophouse facades, Ipoh.

					
S1	S2	S3	S4	S5	S6
					
S7	S8	S9	S10	S11	S12

The condition of each element is evaluated and the result is shown in Table 4. The most affected elements are roof, door, window and wall, due to replacement, deterioration, redesign etc. Eight (8) facades did not retain the original design and material (See Table 5). S12 is the most affected by the improper actions whereby almost all of its elements were intervened followed by S3, S6 and S10. Only S2, S5, S7 and S8 are still above average (50% is considered average) whereby, only three to four elements of the façade have been affected by the improper actions that cause problems.

Table 3: Analysis of improper actions of elements heritage shophouse façades.

Theme	Times	%	Remarks	Conservation
A1 Preserved	43	39.8	In existing condition / well maintained.	Maintenance / Prevention
A2 Deterioration	26	24.1	Wall paint was left peeling.	Rehabilitation / Consolidation
A3 Replacement	24	22.2	Change of terracotta roof to zinc and traditional timber panel door to steel roller shutter.	Restoration
A4 Redesign	10	9.3	Traditional style to modern style.	Reconstruction
A5 Others	5	4.6	Use of temporary steel column instead of brick.	Combination
Total	**108**	**100**		

Table 4: Result of the current condition of the facade.

Theme	Subtheme	A1	A2	A3	A4	A5	Preserve	Problem
F1 Structural	B1 Beam	8	3	1	0	0	7.4	3.7
	B2 Column	5	3	0	0	4	4.6	6.5
F2 Enclosure	B3 Roof	0	0	10	2	0	0	11.1
	B4 Wall	3	7	2	0	0	2.8	8.3
F3 Opening	B5 Door	1	2	7	1	1	0.9	10.2
	B6 Window	2	6	1	3	0	1.9	9.3
	B7 Air-vent	4	4	3	1	0	3.7	7.4
F4 Fenestration	B8 Fenestration	11	0	0	1	0	10.2	0.9
F5 Ornamentation	B9 Ornamentation	9	1	0	2	0	8.3	2.8
		43	**26**	**24**	**10**	**5**	**39.8%**	**60.2%**
	%	**39.8**	**24.1**	**22.2**	**9.3**	**4.6**		

Table 5: Analysis of 12 samples of heritage shophouse facades, Ipoh.

		Elements of heritage shophouse façade										
	Architectural Styles	**F1**		**F2**		**F3**			**F4**	**F5**	**Condition (%)**	
Code		B1	B2	B3	B4	B5	B6	B7	B8	B9	Preserve	Problem
S1	Eclectic	A1	A1	A3	A2	A3	A2	A2	A1	A1	44	56
S2	Early Modern	A1	A2	A3	A2	A2	A1	A1	A1	A1	56	44
S3	Eclectic	A2	A5	A3	A1	A5	A2	A2	A1	A2	22	78
S4	Eclectic	A1	A1	A3	A2	A3	A2	A2	A1	A1	44	56
S5	Transitional	A1	A1	A3	A3	A3	A4	A1	A1	A1	56	44
S6	Art Deco	A2	A2	A4	A2	A2	A2	A2	A1	A1	22	78
S7	Transitional	A1	A1	A4	A1	A3	A4	A4	A1	A1	56	44
S8	Transitional	A1	A1	A3	A1	A4	A1	A1	A1	A4	78	22
S9	Eclectic	A2	A5	A3	A2	A1	A2	A1	A1	A1	44	56
S10	Eclectic	A3	A5	A3	A2	A3	A4	A3	A1	A1	22	78
S11	Neo-Classical	A1	A2	A3	A2	A3	A2	A3	A1	A1	44	56
S12	Modern	A1	A5	A3	A3	A3	A3	A3	A4	A4	11	89

CONCLUSION

This study aims to ascertain the improper actions that lead to the dilemma of retaining the integrity of the heritage shophouses in Ipoh compared to proper conservation approaches. The terms for improper actions were further defined by assessing the current condition of 12 heritage shophouse facades, of which six were subsequently identified. The terms are including preservation, replacement, deterioration, redesign etc. Based on the fieldwork analysis, a few elements of the shophouse façade affected by the improper actions include the roof, wall, door and window. 22.2% of the elements were replaced by changing the traditional timber panel door to steel roller shutters, and terracotta roofs to zinc. 9.3% traditional style redesign to the modern style of the facade. 4.6% of the elements are using different approaches by applying temporary steel columns. Lastly, 24.1% of the elements are deteriorated which involved the peeling of wall paint. In the presence of such information, the local authority can advise the building owners to do restoration works to the affected elements such as maintenance, prevention, rehabilitation, consolidation, restoration, reconstruction or a combination of these conservation approaches.

From this study, the heritage shophouse facades in Ipoh are facing a dilemma mainly deterioration, followed by replacement, redesign and others. The set of terms is applicable for the classification of the current condition of shophouse façades. It is recommended to be applied in the assessment tools or inventories that need to be examined in future research. Besides that, conservation management should be more effective because it is afraid that the improper actions against facades will increase after the pandemic due to business survival in attracting customers or tourists.

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AN ASSESSMENT OF GENDER DISPARITY THAT EXISTS IN THE TRANSIT SERVICE PROVISION: A CASE STUDY OF MRT FEEDER BUS SERVICE IN KLANG VALLEY, MALAYSIA

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Abstract

People are transported from one location to another in cities of Malaysia using a variety of urban mass transit systems. However, in urban area like Klang Valley, where infrastructure development is accelerating, each gender has distinct difficulties and has a different experience utilising public transportation systems. To ensure gender equality for those using public transportation, particularly bus transit, this study tends to reveal the gender differences in perception of MRT feeder bus service quality along the major routes of Klang Valley of Malaysia. MRT feeder buses are seen to have the promise of reducing the increasing congestion in our cities if they are managed effectively and sustainably. As a result, by examining the gender disparities in perceptions of the quality of the MRT feeder transport services, this research broadens the investigation of the MRT feeder bus services. For this study, a quantitative method was used, and convenience sampling was used. The questionnaire was distributed at the chosen MRT Feeder Bus stations along the main routes in the Klang Valley, Malaysia. Results from the survey supported the effectiveness and efficiency of service delivery, demonstrating that both genders found punctuality, waiting times, journey times, and the frequency of MRT feeder buses to be above 80% satisfactory. However, the study found that, there is gender disparity in the connection between gender and the cleanliness of bus stops, the distance from the starting point to the bus stop, and the fear of criminality at MRT feeder bus stations (all stops assessment). According to the results of the factor analysis, six variables can affect passenger satisfaction, including bus reliability, comfort, condition, driver attitude and appearance, access and egress issues, and bus stop evaluation. As a result, it suggests that a high number of women will experience greater fear while travelling on public transportation if inadequate planning and management of the overall public transportation infrastructure design is not remedied. It recommends a complete improvement of safety measures for women and girls as well as an increase in the service frequency of the MRT feeder buses to keep current customers and draw in more new ones.

***Keywords**:* Gender, MRT feeder bus, women safety, service quality, passenger satisfaction, fairness

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INTRODUCTION

Bus service and quality have an impact on how each person makes decisions and plans a variety of activities, including shopping, employment, education, health, leisure, and social gatherings. According to Thynell (2016), mobility is important for growing cities and improves people's quality of life. As a result, each person's wellbeing is favourably correlated with having access to the right mobility options (Pirra et al., 2021). Additionally, in order to have an inclusive bus system, equal access to opportunities, a focus on marginalised groups, and a reduction in the negative externalities of transportation for everyone are necessary (Boisjoly & Yengoh, 2017). Likewise, inclusive mobility may play a significant role in reducing social segregation (Gauvin et al., 2020). Physical, geographic, economic, facility, and exclusion linked to time and fear are further categories used by Pirra et al. (2021) to categorise mobility restrictions. to ensure that all people, regardless of gender, can use public transportation, such as bus service. In order to prevent the development of barriers and disparities for women, a gender assessment of the mobility analysis has been included (Sanchez & Gonzalez, 2016). In general, women commute more than males, with the exception of trips related to employment, where men commuted the most (Olmo & Maeso, 2013). According to Simievi et al. (2016), gender is one of the demographic characteristics that has a greater impact on travel behaviour. There may be a gender gap in views of service quality, according to extensive studies on gender and travel behaviour (Abenoza et al., 2018; Namgung & Akar, 2014). Because of differences in their unique travel needs, preferences, priorities, and access levels, male and female passengers perceive bus service differently (Fu & Juan, 2017).

Critical factors for the public transit ridership gap include the rise in gender imbalance in transit utilisation (CSE, 2019). The development and promotion of public transit as a sustainable method of transportation has been a focus of planners and policymakers. The investigation of gender and passengers' opinions of the quality of transport services, however, receives little attention from transit authorities (SQ). Studies on SQ evaluation with a differentiation in gender can aid in the formulation of gender-specific policies that will both maintain current users and draw in new ones (Jyoti et al., 2021). For instance, Mandhani et al. (2021) noted that while evaluating service quality elements, females prioritise "waiting conditions" and "punctuality" whereas males choose "service frequency" and "vehicle cleanliness." In a similar vein, Arabikhan et al. (2016) discovered that females have higher expectations and lower perceptions of bus service than males do. Despite strong signs to the contrary, gender imbalance has not been adequately addressed in literature on service quality. Therefore, it is crucial to investigate the relationships between gender difference and service quality. In order to meet necessary demand and boost bus usage, transportation providers and legislators should effectively strategize gender-specific strategies. Due to the aforementioned gaps in the literature, the current study's goal is to investigate and determine how service quality relates to both male and female passengers along the MRT feeder bus service routes in Malaysia's Klang Valley and at the same time evaluate overall level of satisfaction of the MRT feeder bus by both genders. The implementation of effective and fair transportation standards that will benefit all users, lessen discrimination based on gender, and enhance current transportation options for women. In order to formulate gender-specific policy measures, it was necessary to identify the component that needed to be given priority in the study's determination of the existence of gender discrepancy in the perceptions of service quality.

RESEARCH BACKGROUND

Rider perceptions of bus service have been the subject of several studies, including Arabikhan et al. (2016) and Echaniz et al. (2018). These studies have shown that changing rider perceptions can significantly enhance service quality, increase transit use, and lessen urban problems.

The accessibility of public transportation and how it accommodates different genders' needs for mobility have received relatively little attention. There have been few research that look at the problems women have choosing their modes of transportation and whether there is a big gender gap. The majority of research on urban mobility has been done in developed nations; Malaysia and other emerging nations, particularly, have limited information on this topic. By examining gender differences in the MRT feeder bus use and accessibility in the Klang Valley, Malaysia, this study aims to close this gap.

Gender Differences in Mobility Trip Patterns

Women travel more than men do in metropolitan places around the world (Ng & Acker, 2018). Men, in contrast, make direct and linear travels from work to home. However, to integrate many obligations linked to childcare and household chores, women have been known to "trip-chain" in advanced and emerging market economies. This involves taking multiple multi-purpose excursions in a single trip (Peters, 2013).

Bus transportation is a poor alternative for women who must balance a lot of activities because it is also much more punishing for them to lose time while travelling (Pirra, 2021). Other factors, like family, exacerbate the variations in mobility patterns between the genders that have been identified. Women travel more frequently than males do in cities around the world (Ng & Acker,2018). Women, on the other hand, use "trip-chaining," as it is known in advanced and emerging market economies, which combines multiple multi-purpose trips into one trip, to combine different responsibilities related to childcare and household work. Men, on the other hand, do have linear and direct trips between work and home (Peters, 2013). Moreover, women are more likely to travel with children. Their movements are coordinated with their children's mobility patterns and requirements (Peters, 2013; Scheiner & Holz-Rau, 2017). As more women participate in the labour market in both formal and informal sectors, women's travel habits become even more complicated as a result of the need to juggle family and professional obligations. Bus transportation is a poor alternative for women who must balance a lot of activities because it is also much more punishing for them to lose time while travelling (Pirra, 2021). Other factors including family wealth, location, age, and social background exacerbate the variations in movement patterns between the sexual practice that have been identified (Pirra, 2021).

Additionally, according to Berg and Ihstrom (2019), some of the major obstacles to adopting public bus usage are the distance between homes and bus stops, the poor coordination of bus routes, long wait times, a lack of connectivity between services, the lack of schedule adjustments during peak hours, and the safety of the route connecting the home to the nearest bus stop.

Women Safety and Security Concern in Bus Usage

1. The security and safety of public transportation is one of the most important variables influencing women's mobility decisions to use it. Therefore, safety could be described as "the prevention of unintentional tragedies as floods, earthquakes, and accidents at work, whereas security is the prevention of unintentional unpleasant activities by people, such as robbery, mugging, and terrorist operations" (Candia et al., 2019). Women, regardless of age or background, are typically more worried with their safety and personal security since they are more likely to be exposed to high levels of violence, which influences the mode of transportation chosen. In terms of mobility, when there is a perceived threat, women could choose a less effective or more expensive alternative (Singh, 2020).

2. In support of Singh's (2020) discovery, the international transport forum (ITF, 2018) publication "women's safety and security: a public transport priority," published by the oecd publishing, paris, provided some figures. The report claimed that 80% of women and girls have seen harassment in public and that 80% were concerned about being harassed when using public transportation. Even though there is a rising problem with sexual harassment on public transportation, there is a significant underreporting problem because 90% of incidents go unreported (ITF, 2018).

3. Changes in the design of transportation interchanges and waiting places, such as bus stops, may be necessary to address personal security issues where security concerns, such as crime and violence, are perceived as being more dangerous to people's safety, particularly women and girls (Coppola & Silvestri, 2020). Contrastingly, the presence of police or transportation workers for monitoring appears to have a greater influence on reducing women's fear of crimes than interventions like security cameras and lights (Hortelano et al., 2019). Coppola and Silvestri (2020) validated the gender discrepancy between perceived and accurate perception in terms of safety and security in a bus station, finding that women do indeed feel less safe. The study supports previous findings about the placement of security cameras, which only men notice, lessening the likelihood that people will feel less afraid of entering these locations. Typically, women's movement may be constrained by apprehension about sexual harassment on public transit. This issue becomes more urgent since women are more likely than males to rely on public transportation to meet their mobility demands.

METHODOLOGY

A quantitative methodology was used in this study. The method used to collect the data was a self-administered questionnaire, which is the most popular method for assessing passengers' thoughts. At the chosen MRT feeder bus stations in the Klang Valley, survey forms were distributed using convenience sampling. The most congested MRT stations were chosen as the sampling frame for the study (based on observer counts in the pilot survey). A total of 380 passengers were chosen as the sample size, as advised in the research of Kadir et al. (2020) and Olabayonle et al., due to the huge population for the entire MRT feeder bus stops (2021). By using convenience sampling, 380 questionnaires were sent to passengers at the chosen mrt feeder bus stations. The remaining surveys were filled out by people waiting at bus stops who did not ride the MRT feeder bus, making them ineligible to serve as the study population. Only 303 (79.7%) were valid and subjected to additional analysis.

All of the data was collected over a six-month period, from September 2019 to March 2021. Prior to Malaysia's first lockdown due to the Covid-19 pandemic. In this study, the enumerator will ask the questions and the respondents' responses will be recorded, resulting in higher quality data and a greater response rate. Chua (2013) recommends on-field surveys when the desired sample includes respondents from a highly particular target population. This method is deemed appropriate for this study since the respondents are highly knowledgeable persons with the necessary experience to comprehend the MRT feeder bus transit system issue.

There were three sections in the questionnaire. The first part of the questionnaire asked questions on the respondents' sociodemographic profiles. The trips characteristics were explored in the second section. Here, participants were questioned regarding their purpose of their trip, how often they utilised MRT feeder bus and the travel time. The diverse user experiences with using MRT feeder bus service were the emphasis of the third section. It examined the bus service quality in term of their respective level of satisfaction. Participants were asked to express their level of agreement or disagreement with a number of issues, including the bus conveniences, bus reliability, bus condition, driver's attitude and behaviour, degree of difficulties in ingress and egress and lastly the bus station assessment for example the safety, cleanliness among others. Service qualities, served as the dependent variable in this study while the respondents' sociodemographic details, including their gender, income, level of education, and travel habits, are independent factors. For the purpose of presenting the descriptive findings, such as the frequency analysis and the cross-tabulation of variables, the data were analysed using IBM Statistical Package for Social (SPSS) software, version 24.

DISCUSSION OF FINDINGS

Demographic Background of the Passengers

Following is an analysis and presentation of the passenger's demographic background, which covers gender, age group, educational attainment, household income, and employment position. Table 1 reveals that 37.3% of the passengers were men and 62.7% of the passengers were women. Of all respondents, 62.7% are in the 20 to 29 age group, which is the most economically active. The remaining amount was split between those who were 30 to 39 years old (12.5%). 12.5% of respondents were under the age of 20, while 6.0% were over the age of 40. Additionally, a higher percentage of travellers than usual (64.4%) had a bachelor's degree or higher, while 35.6% had high school or college diplomas. The average monthly income of some passengers (45.9%) was over RM6,000, while that of 21.8%, 16.5%, and 15.8% was between RM2,000 and RM3,999. It is obvious that those with high incomes opted out of using public transportation; this was likely owing to their access to and ownership of private vehicles.

The users who were intercepted also included 48.8% of students, 43.9% of people working in the business sector, 4.6% of people working in the public sector, 1.7% of women who were housewives, and 0.7% of those who were seniors or retirees. According to the research, women between the ages of 20 and 29 make up the majority of daily MRT feeder bus service patrons. Thus, it's important to determine whether there is or is not a gender imbalance in the supply of services. Table 1 showed the gender differences in perception of service level of satisfactory of MRT feeder bus service provision particularly safety, ingress and egress as these two indicators are gender sensitive. In several of the variables assessing the impact on satisfaction levels, both genders were satisfied with the MRT feeder bus services. These include the degree of onboard convenience, the bus' reliability, its physical condition, the driver's attitude, and the ingress and egress challenges. The results may have been caused by respondents' dependence on buses, given that many of them are low-income earners and the MRT feeder bus service is a relatively new piece of infrastructure. As the result is contradict the claim of many other studies such as Rohana et al. (2018), Ahmad and Shefa (2017), Mubarok & Suparman (2019) which proved otherwise. However, compared to other countries in Asia, Malaysia is doing great as per the public bus transport satisfactory with the service provision is concerned. For example, in many of Indonesia's major cities, it is still difficult to locate a convenient, secure public transit option (Mubarok & Suparman, 2019). But as Malaysia working toward achieving United Nation’s Sustainable Development Goals (SDG 11) on sustainable cities (access to transport and expanded public transport). Only 20% of people currently use public buses, which is a low percentage compared to Malaysia's National Transport Policy (NTP) 2019–2030's target of 40% by the end of 2030. The low use of public bus transportation is attributed to the benefits of private transportation especially women, including flexibility, comfort, privacy, and safety (Ibrahim et al., 2021). As a benchmark, countries like Singapore and Australia, feeder bus services in Malaysia still require improvement in a number of areas, including frequency of service, cleanliness and comfort while waiting for the bus at the bus station, hours of service, and reliability of service, among others, to keep the current users and attract the interest of high-income earners. Numerous studies undertaken in Malaysia (Shaharrudin et al., 2018; Chuen et al., 2014; Borhan et al., 2019; and Abdul Jalil et al., 2015) have shown a steady rise in the number of people relying on private cars, particularly in the Klang Valley. The study's findings regarding the evaluation of bus stops showed that several of the metrics utilised to measure female satisfaction with bus stops were unsatisfactory. These include the bus stop's condition, its location in relation to its respective origins, and its safety and security (fear of crime) factors (Table 2).

Table 1: Gender Differences in the Satisfaction of Passengers with the MRT Feeder Bus Service

Element		Measurement Scale			
		Very Dissatisfied %	Dissatisfied %	Satisfied %	Very Satisfied %
Convenience of buses					
Information and guidance	M	1.0	3.3	23.1	9.9
	F	0.0	5.0	35.0	22.8
Ease of boarding or alighting bus	M	1.0	2.3	21.5	12.5
	F	0.0	2.3	36.0	24.4
Seat Availability	M	1.7	2.3	23.4	9.9
	F	1.3	3.6	35.3	22.4
Seat Comfort	M	1.7	3.0	23.4	9.2
	F	0.3	4.3	37.6	20.5
Crowdedness	M	2.3	2.6	23.1	9.2
	F	0.7	4.0	37.3	20.8
Air Conditioning	M	1.7	2.0	21.8	11.9
	F	0.0	2.0	37.6	23.1
Cleanliness	M	2.0	2.3	22.4	10.6
	F	0.7	3.0	35.6	23.4
Physical Condition	M	1.3	2.3	22.8	10.9
	F	0.0	1.7	38.9	22.1
Other Bus Users Behaviour	M	1.0	3.0	23.4	9.9
	F	0.0	3.6	37.0	22.1
Vehicle Breakdown	M	1.3	2.0	21.8	12.2
	F	0.0	2.3	37.0	23.4
Reliability of the Bus					
The bus arrives on time	M	3.0	9.2	19.5	5.6
	F	5.9	17.2	29.4	10.2
Bus departs on time	M	3.6	7.6	19.5	6.6
	F	7.6	15.2	31.0	8.9
Travel Time	M	2.6	7.6	22.1	5.0
	F	5.6	16.5	32.3	8.3
Service Frequency	M	3.0	8.6	19.5	6.3
	F	2.6	17.8	30.0	12.2
Safety while onboard	M	0.7	3.6	25.4	7.6
	F	0.0	6.3	38.6	17.8
Bus Condition					
The appearance of the Bus	M	1.0	3.0	15.2	18.2
	F	0.0	2.0	29.7	31.0
Storage Availability in the Bus	M	1.0	4.0	13.9	18.5
	F	0.3	3.6	29.0	29.7
Provision and Visibility of Handrails	M	0.7	2.6	17.5	16.5
	F	0.3	1.0	31.7	29.7
Shape or diameter of Handrails	M	0.7	2.0	23.8	10.9
	F	0.0	3.0	38.6	21.1
	M	0.7	3.0	23.4	10.2

Passenger Injured due to the Handrails	F	0.3	2.3	36.6	23.4
Bus Spaciousness	M	0.7	3.3	15.5	17.8
	F	0.3	1.7	29.7	31.0
Driver Behaviour/Attitude					
Physical Appearance of the Driver	M	0.7	2.3	25.1	9.2
	F	0.0	4.0	38.0	20.8
Helpfulness of the Driver	M	1.0	2.6	22.4	11.2
	F	0.3	5.9	35.6	20.8
Improper Bus Parking	M	1.0	1.7	25.7	8.9
	F	0.3	3.0	39.6	19.8
Degree of Difficulties in Ingress and Egress of the Bus Passenger					
The gap between kerb and bus is wide	M	1.0	2.0	19.1	15.2
	F	0.0	3.6	33.7	25.4
Steps are too high or otherwise	M	0.7	2.3	17.5	16.8
	F	0.3	2.3	35.0	25.1
Kerb Level Vary with the Bus Level	M	0.7	2.3	18.5	15.8
	F	0.0	3.3	32.7	26.7
Comfort Level of handrails	M	0.7	2.0	17.5	17.2
	F	0.3	1.7	33.3	27.4
Handrail Access during Ingress/Egress	M	0.7	2.3	18.5	15.8
	F	0.0	2.0	35.6	25.1
Preference mode of Ingress/Egress	M	0.7	2.3	16.8	17.5
	F	0.3	2.0	36.0	24.4
Ease of Carrying bags while Ingress/Egress	M	0.7	2.0	18.5	16.2
	F	0.0	2.0	35.0	25.7
Possibilities of Stumbling on moving Buses	M	1.0	3.3	15.8	17.2
	F	0.3	2.6	34.3	25.4
Bus Stops Assessment					
Bus Stop Cleanliness	M	0.7	3.3	18.2	15.2
	F	0.0	4.0	33.7	25.1
Information before travel, during and after alighting	M	0.7	3.3	19.5	13.9
	F	0.3	4.3	34.3	23.8
Bus Stop distance from the final destination	M	0.7	3.3	17.5	15.8
	F	0.3	2.6	36.0	23.8
Fear of crime at the bus stop	M	1.7	2.6	19.1	13.9
	F	**24.4**	**34.0**	4.3	0.0
Shelter provision at the bus stop	M	1.3	2.0	19.1	14.9
	F	0.3	3.6	34.0	24.8
Seat comfort	M	1.3	2.0	18.5	15.5
	F	0.7	4.0	34.7	23.4
Condition of the bus stop	M	1.3	2.6	17.2	16.2
	F	**35.0**	**24.4**	3.3	0.0
Routes map at the bus stop	M	1.3	2.6	17.8	15.5
	F	0.7	4.3	34.0	23.8
Distance to the bus stop	M	1.3	2.3	18.2	15.5
	F	**24.8**	**35.3**	2.6	0.0

Segment Analysis for Gender

There has been an increase in discourse on providing gender-specific services in public transportation (Ceccato (2017); Ceccato & Loukaitou-Sideris, 2020). In order to examine this, the study went on to analyse the quality of the bus service in relation to gender-specific issues. Analysis was conducted to teat the relationship between gender and crime fear at each chosen MRT feeder bus stop, and it was found that the P-value for the chi-square test was 0.035, which was less than 0.05. The null hypothesis was rejected and it can be concluded that, at the MRT feeder bus stops, there is a significant correlation between gender and safety and security "fear of crime." The majority of people were satisfied with their respective safety quality, indicating that the overall safety concern at the bus stations was widely shared (Table 1). However, further statistical analysis showed the gap in perception between the genders.

Women's mobility is hampered by dangerous public transportation, according to Ceccato (2017). As a result, it necessitates a comprehensive strategy to safety, which includes realising how victimisation and fear interact. Therefore, it is believed that victimisation and fear are both influenced by an individual's qualities and their intersection, in addition to gender (Ceccato & Loukaitou-Sideris, 2020). A second test was conducted to find the relationship between gander and the satisfaction on the bus stop condition and it was found that the p-value was 0.033, which was less than 0.05 and therefore, the null hypothesis is rejected. In other words, the gender assessment of the state of the bus stop is significantly correlated with it.

Table 4: Relationship between gender and the distance to bus stop from the origin

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	8.142[a]	3	.043
Likelihood Ratio	9.302	3	.026
Linear-by-Linear Association	.855	1	.355
N of Valid Cases	303		

The third test was conducted to test the relationship between Gender and the perception of the distance from the origin to the bus stop, and based on the result shown in table 4, the chi-square test revealed that the p-value was 0.043, and therefore the null hypothesis is rejected. The study found, there is a significant relationship between gender and the perception odistance from the origin to the bus stop. The study discovered that overall perception for a new service system was positively skewed, owing to high-quality infrastructure installations in the first few years of operation. At first glance, many users perceived safety as a positive overall quality. However, a closer look at user type differentiation revealed the opposite, indicating some gender issues such as fear of crime, bus stop conditions, and the distance to the bus stop from the origin that still falls short of the quality expected by female riders. This important finding lends support to other recent studies on equality issues (Peters, 2013; Pirra et al., 2021).

Exploratory Factor Analysis

The exploratory factor analysis (EFA) identified the potential structure of the latent variables, which is commonly used to reduce variables to a smaller and manageable size after removing the items that did not have the common cores identified by Ibrahim et al (2021). The principal component (PC) technique for EFA was chosen in this study because it is highly recommended and widely used in many applications to identify latent variables in transportation studies by several researchers such as Obsie et al. (2020) and Morton et al. (2016). In this study, the factor with Eigenvalues greater than one was kept (Ibrahim et al., 2021; Maskey et al., 2018). An exploratory analysis was performed on 44 items to assess the level of service provided by the MRT feeder bus. Six factors were identified as having eigenvalues greater than one and total variance of 77.292%, namely bus convenience (11), bus reliability (6), bus condition (5), driver appearance/attitude or behaviour (5), difficulties in ingress and egress (8), and bus stop assessment (9) Two items with less than 0.5-factor loading were removed, as recommended by Maskey et al. (2018) and Uca et al. (2017). In EFA, the varimax rotation method was used to identify critical factors and facilitate interpretation (Hair et al., 2014). The Kaiser-Meyer-Olkin (KMO) and Bartlett's tests of sphericity, factor loading of the items, and reliability analysis of each identified factor are the main criteria considered in EFA. Table 6 shows that the KMO value (0.939) and Bartlett's test of sphericity (2 = 18224.853, p 0.000) are significant, indicating that the inter-correlation matrix has an adequate common variance. The factor analysis has a high level of sampling adequacy (Hair et al., 2014). Table 5 also shows that the factor loading ranges from 0.506 to 0.819 for all samples, with factor loading greater than 0.50 indicating satisfactory factor loading (Kuo and Tang, 2013). Finally, the reliability result shows a Cronbach's alpha value greater than 0.70 as a threshold. Cronbach's alpha for all factors ranges from 0.893 to 0.976, meeting Hair et al. (2014) recommendation. The results indicate that the six extracted factors are extremely reliable.

Table 5: Result of the exploratory factor analysis of the MRT feeder bus service

Factor/Item	EFA Factor Loading	Eigenvalue	Explained Variance	Cronbach's Alpha
Bus Convenience (BC)		23.918	23.699	0.971
BC 1	0.739			
BC 2	0.745			
BC 3	0.692			

BC 4	0.716			
BC 5	0.747			
BC 6	0.744			
BC 7	0.742			
BC 8	0.751			
BC 9	0.738			
BC 10	0.754			
BC 11	0.758			
Bus Reliability (BR)		4.035	3.812	0.893
BR 1	0.512			
BR 2	0.506			
BR 3	0.619			
BR 4	0.595			
Bus Condition (BCD)		2.573	2.354	0.954
BCD 1	0.774			
BCD 2	0.782			
BCD 3	0.805			
BCD 4	0.812			
BCD 5	0.819			
Driver Appearance (DA)		2.019	1.812	0.944
DA 1	0.706			
DA 2	0.725			
DA 3	0.671			
DA 4	0.718			
DA 5	0.719			
Difficulties in Ingress and Egress (DINEN)		1.541	1.336	0.976
DINEN 1	0.815			
DINEN 2	0.782			
DINEN 3	0.807			
DINEN 4	0.831			
DINEN 5	0.831			
DINEN 6	0.806			
DINEN 7	0.819			
DINEN 8	0.802			
Stop Assessment (SA)		1.187	0.994	0.966
SA 1	0.742			
SA 2	0.741			
SA 3	0.766			
SA 4	0.734			
SA 5	0.719			
SA 6	0.750			
SA 7	0.764			
SA 8	0.749			
SA 9	0.742			
KM0 = 0.939, χ^2 = 18224.853, p < 0.000 Total variance explained = 77.292				

Note: EFA = Exploratory factor analysis, KMO = Kaiser-Meyer-Olkin measure, χ^2 = Bartlett's test of sphericity.

CONCLUSION AND RECOMMENDATIONS

In conclusion, women tend to favor more flexible means of transportation because they have more intricate travel schedules than men do, but they also find public transportation to be more appealing. This suggests that new trends like MRT feeder bus service may draw more female users than male users, making flexible modes more appealing to women. Women may decide to give up driving altogether if better options are available. Cities should create rules that take into account women users' preferences since they will make up the majority of users if they wish to further promote the development of flexible and sustainable forms of transportation.

The majority of cities especially in the asia continent lack transportation policies or programs that are aimed at enhancing the transit user experience for women riders, despite the fact that they prefer to use public transportation more than men do and that most of their trips are not for commuting purposes and take place during off-peak hours. Vienna is one city whose urban development does take gender into account. Before an infrastructure project begins, data is gathered to ascertain how various groups of people use public transportation and spaces. This practice was sparked by a survey on men and women's usage of public transportation conducted in the late 1990s. Women's preferences and choices for mobility are significantly influenced by variables related to transportation safety and security, particularly in urban regions where more women than males utilize public transportation and strongly rely on these systems to go around. Examples from the itf's compendium on women's safety and security: a public transport priority (2018) demonstrate that the majority of women in the world experience unsafe conditions in public transportation and have experienced various forms of physical or verbal harassment as well as other types of violence in open areas. In order to avoid this, when given the option of taking public transportation, walking, cycling, or driving themselves, taxis, or other for-hire ride services, are frequently chosen by women.

Alarming statistics show that women in many asian nations have significant levels of inequality in access to economic resources and possibilities for livelihood. Take bangladesh, for instance. Despite owning only 8% of the productive assets in rural areas, women still only make up a small portion of the workforce, at an estimated 34%. The percentage of women who commute on public transportation who have encountered sexual harassment—verbal, physical, or other forms—is estimated to be over 94%. In jakarta, almost 90% of women said that the safety of public transport was poor or very poor, compared to only 35% of men who shared the same worry about security (turner, 2013). The safety of cities' public transportation systems must be taken into account if they want to raise ridership and occupancy rates. This will help draw in more female travellers and enhance the travel experience for the large proportion of existing female users.

Thus, it is crucial to comprehend how various variables could affect general satisfaction with public transportation from the standpoint of developing policies. This knowledge can be utilised to more carefully choose the variables for market segmentation studies, which will aid in the improvement of target definition and investment acuity on the part of public management. Gender has a negligible impact on overall satisfaction, according to the study's findings. The results do show that women are more likely to criticise the services that are expected of them and those that are actually provided. As an illustration, the women's sample gave lower ratings to every attribute that was evaluated differently based on gender. Women, however, gave the majority of service qualities a higher priority than did males. Since money and travel goals can be utilised as predictors of gender, these variations may be rooted in differing usage and socioeconomic descriptive value. Women also stated that they experienced more dangerous situations, congested living circumstances, more feeder usage, all of which had a negative impact on satisfaction.

This study has found disparities between genders in how satisfied people are with the following three aspects of mrt feeder bus service: the security and safety at bus stops, the condition of the bus stops, and the distance from the origin to the bus stops. The goal of this study was accomplished by identifying gender differences in the degree of satisfaction with the services offered by feeder buses. These services include bus punctuality, frequency of service, seat availability, waiting time, travel time, and safety, among others, all of which need to be improved to stop women and girls' and women's continued growth in personal mobility, particularly in the central klang valley. Aside from bus arrival and departure timings and bus travel time, the study found that riders were generally happy with the service. Future research possibilities can look at the causes of such appraisal in more detail. The study did find gender disparities with regard to the issue of crime fear at the bus stop, the state of the bus stop, and the travel time from the point of origin to the bus stop. The results of this study are anticipated to help mrt feeder bus operators understand how gender variations affect the elements that affect how often people use the mrt feeder buses and, ultimately, how to improve the services. An increase in users, particularly among women and girls, high- and middle-income individuals, and eventual revenue maximisation could result from improved services, particularly in flm travel, waiting times, and safety. Future studies are advised to include non-users in their research to identify the barriers preventing the use of public transportation.

Men tend to prioritise service performance characteristics like reliability, service frequency, and travel time, while women prioritise comfort characteristics like vehicle interior conditions, fleet conditions, bus stop infrastructure, safety and security, and crowding conditions. This finding was supported by the factor analysis, which explained variance. Since the relative relevance data analysis did not yield enough solid evidence to substantiate it, further research is required. Additionally, as it would offer data from a more complicated context, the influence of gender should be further researched in multimodal investigations.

Specifically for the policy maker, putting in place systems that ensure a systematic collection of pertinent gender-disaggregated data (usage and provision) on access to and use of infrastructure by type, such as transportation, to inform infrastructure project planning and design is the first step in making the case for applying a gender lens to infrastructure projects.

A second phase entails creating frameworks for infrastructure design that consider the connections between infrastructure and the well-being of both men and women as well as societal objectives for environmental conservation. Throughout the project life cycle and during the project development and design phases, a gender analysis must be conducted as part of this process. Such an analysis ought to be connected to the strategic vision for infrastructure, which ought to incorporate environmental goals in addition to gender-specific priorities, demands, and usage of various facilities.

The lack of gender-sensitive governance in decision-making and throughout the value chain of infrastructure projects is addressed in the third stage. In order to ensure that infrastructure projects take into account the various needs and uses of infrastructure by various groups of women and men, as well as environmental considerations, it is crucial that women are well represented in the public positions that matter for decision-making throughout the infrastructure investment cycle. Infrastructure firms must also make sure that female workers are not subjected to discrimination and are given the chance to advance their careers.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

AUTHOR CONTRIBUTIONS

All the listed authors have made substantial contribution to the work and approved it for publication

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RISKS DURING THE DEVELOPER'S MANAGEMENT PERIOD FOR STRATA RESIDENTIAL PROPERTY IN MALAYSIA

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Abstract

The property developer would be in a vital role to orchestrate the development and ensure the issuance of the strata title. Developer's Management Period will take place right after the property completion if the strata title has not been issued during the delivery of vacant possession to the parcel owners. Concentrating on the property developer during the Developer's Management Period, this study aimed to investigate the risks associated with the management of strata-titled properties as a strategy to further understand the needs of managing the property from the earliest stage. This study was adopting the analytical review of the literature, content analysis of the documents and thematic analysis from the semi-structured interviews with the industry players. This study has identified the employees' competencies, financial liquidity, non-compliance to the laws, litigation, customer service and security management as six risk factors that the developers must be concerned about in managing strata-titled properties. Afterwards, developers may continue to do risk assessments and risk mitigation as parts of the risk management process.

Keywords: Developer's Management Period, Strata Residential Property, Property Developer, Property Management Risks, Malaysia

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INTRODUCTION

In 2020, the urbanization rate in Malaysia reached 77.6% and would reach up to 80% in 2030 (Ministry of Housing and Local Government, 2022). It was about 25.7 million of the Malaysian population in the year 2020 lived in cities and urban areas. In meeting the urbanization needs, strata-titled developments have become part of the answers to accommodate the growing demands from economic activities, escalation of populations and solving the issue of limited spaces in the matured, prime and strategic areas (Tee, 2016).

Strata-titled developments would mostly be in the form of high-rise buildings although there are landed properties under the strata title as options for buyers. Developers are moved to develop vertical developments or high-rise buildings because they have limited development space but still offer good profitability through maximization of development density. Considering that people are getting used to living in vertical development has made the developers compete aggressively in securing strategic locations in the central business district (CBD) and urban areas. To them, product offering must meet what the customers want, because real estate product is exposed to various influencing factors such as location, infrastructure, accessibility, facilities, development concept, product design, competitive pricing, government policies, consumer sentiment, brand, marketing, good building services and efficient property maintenance and management, which the customers would choose according to their preferences (Tee, 2016).

Property developers are aware of the necessity for having good building services and efficient property maintenance and management for collective well-being amongst the occupants as well as preserving the physical and investment value of the property. Many property developers are willing to do property management and stay longer after the development completion mainly to have control of the property and make businesses from it. Records have shown that in 2018, 30% or 6,372 of 21,222 strata-titled residential units and 33% or 7,368 of 22,345 of strata-titled residential units during 2019 in Malaysia were managed by property developers (Cawangan Pengurusan Strata, 2018, 2019). But the strata laws in Malaysia have restricted that by putting the conditions and time frame for the property developer to hand over the management of the property to owners. Property developers are allowed to manage the property only within the Developer's Management Period as specified in the Act.

This study has set its scope to study property management by the property developer within the time frame between property completion and handing over to the Joint Management Body (JMB) or Management Corporation (MC). The aim is to identify the associated property management risks faced by the property developers during the Developer's Management Period. This study was filling the gap of other studies, which mostly studied property management stages after the management handover from the developers.

LITERATURE REVIEW
Strata Management

Strata-titled properties are comprehensively bound by the laws which enforce the related parties to comply with all the requirements accordingly. They are regulated mainly by the Strata Titles Act 1985 (Act 318) and Strata Management Act 2013 (Act 757). Before Act 757, there was the Building and Common Property (Maintenance & Management) Act 2007 (Act 633) (repealed) that regulated proper procedures for the maintenance and management of the strata properties including the formation of Joint Management Body and Management Corporation. Both Act 633 (repealed) and Act 757 have given the power for the appointment of the Commissioner of Building (COB) in every local authority to administer and carry out the act's provisions through monitoring and enforcement. COB carries the power to supervise the developers, Joint Management Bodies, Management Corporations, proprietors, and occupants on practice compliances.

Apart to accommodate the abovementioned main laws, there are Strata Management (Maintenance and Management) Regulations 2015, Strata Management (Strata Management Tribunal) Regulations 2015, and Strata Management (Compounding of Offences) Regulations 2019 to further expand the legislation controls for the practice. Nevertheless, other statutes and regulations such as the Housing Development (Control and Licensing) Act 1966 (Act 118), Valuers, Appraisers, Estate Agents and Property Managers Act 1981 (Act 242), Housing Development (Control & Licensing) Regulations 1989, Malaysian Property Management Standards, just to name a few, are also in place to regulate the practice whether directly or indirectly. The existence of the Strata Management Tribunal is part of the strategies by the government to facilitate strata unit owners to handle disputes regarding strata management. The tribunal can handle cases with a maximum claim of up to RM250,000 has helped the strata residents to get quality living because the tribunal can solve disputes among the strata residents within a shorter period and at a lower cost (Ng, 2018; Tan, 2019).

Part IV of the Strata Management Act 2013 (Act 757) has permitted property developers to take the role of building manager for their newly completed stratified property during the Preliminary Management Period or Developer's Management Period. The period is starting from the delivery of the vacant possession date until the formation of a Joint Management Body (JMB) or Management Corporation (MC) depending on the opening status of a book of the strata register and the presence of a Management Corporation (MC) (Bahari, 2019; Lai, 2016; REHDA Institute, 2018).

Table 1. Statistics for JMB/MC establishment by year in a residential strata-titled development

Year	Total strata-titled development for residential	Total number of JMB/MC establishment	Percentage of JMB/MC establishment
2019	22,345	10,945	48.9%
2018	21,222	9,236	43.5%
2017	20,441	9,142	44.7%
2016	19,923	8,888	44.6%

Source: Cawangan Pengurusan Strata (2016, 2017, 2018, 2019)

As presented in Table 1, the percentage of strata-titled residential properties under the management of JMB and MC was never getting more than 50%. In 2018 and 2019, there were 6,372 and 7,368 strata units respectively under the management of developers (Cawangan Pengurusan Strata, 2018, 2019). Based on yearly progression, it can be inferred that the strata properties until now are largely under the management of property developers together with the managing agent and other managing bodies. It is inevitable considering that both the government and private sector are supplying strata properties to support various national housing programmes, especially to accommodate the demands of low and medium-income groups (Ministry of Housing and Local Government, 2022). So, this paper would like to emphasize that Developer's Management Period is crucial because the number of property developers who still managing the properties is high and considering the long extent of their availability in managing the property.

Developer's Management Period

Clause 12, 25, 27 and 28 of the Schedule H of Housing Development (Control and Licensing) Regulations 1989 have stipulated that the developer is responsible to apply for building or land subdivision together with separate strata titles and delivering the issued strata titles during the delivery of vacant possession to the purchasers. Nevertheless, an exception is given to the developer if the issuance of strata titles to the said parcel is late or not issued due to certain conditions which not attributable to the developer but must be accompanied by a written certificate by the Controller to deliver the vacant possession within 36 months from the date of Sale and Purchase Agreement.

In congruence with Schedule H, Figure 3 has illustrated the Part IV and V of the Strata Management Act 2013 (Act 757) on two situations or processes of strata management whether strata titles have been issued or not during the delivery of vacant possession to the purchasers. The first situation is where the developer has delivered vacant possession of the parcels in the development to the purchasers after the issuance of strata titles, which initiates the Preliminary Period because the Management Corporation (MC) is reckoned as being established. But until the 1st Annual General Meeting (AGM) of MC is conducted to elect the management committee, the developer will manage the property (HBA, 2019). There is a condition that the 1st AGM of the MC can only be arranged after 25% of the aggregate share units of the development area in the respective strata titles have been duly registered in the interest of the parcel owners (Rabe *et al.*, 2021; Tan, 2019).

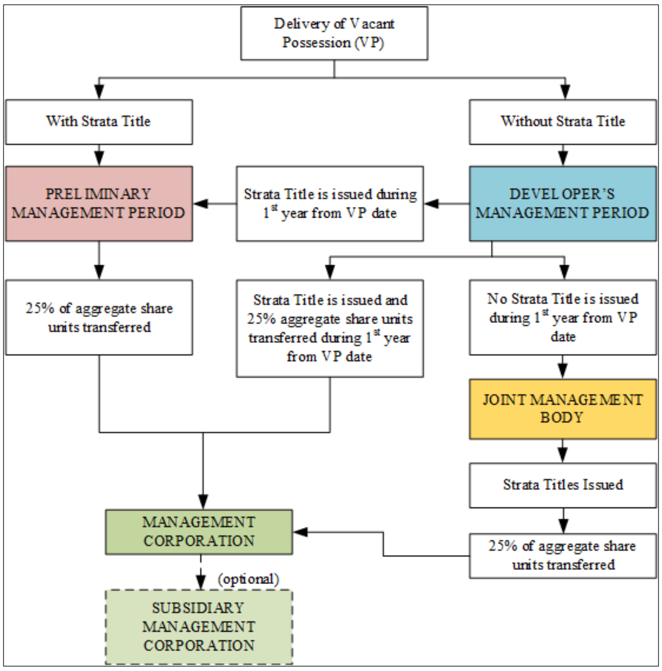

Figure 3. The flow of Management Corporation Formation for Strata-Titled Property
Source: REHDA Institute (2018)

The second situation is illustrating the Developer's Management Period where the developer has delivered vacant possession of the parcels in the development to the purchasers before the issuance of strata titles (Tan, 2019). As shown in Figure 4, the developer is allowed to manage the property for a maximum period of 12 months from the delivery of the first vacant possession of the units. The developer must call for the First Annual General Meeting of JMB within those 12 months and need to hand over the property within one month after the meeting (REHDA Institute, 2018).

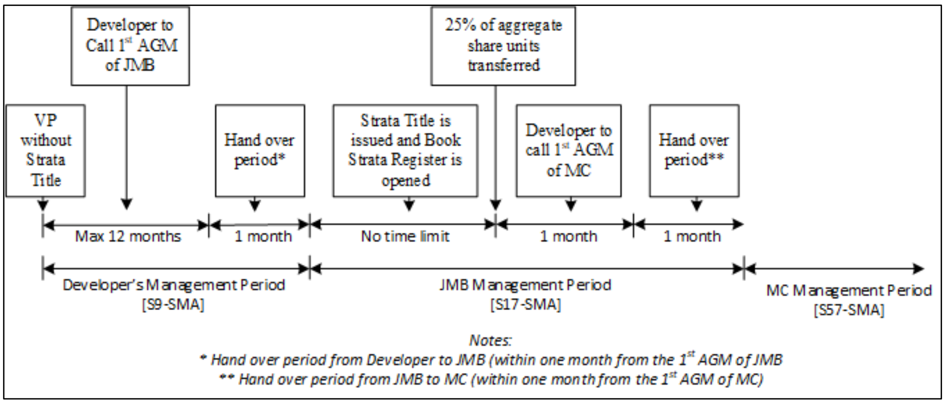

Figure 4. The timeline for the formation of a Management Corporation in Strata-Titled Property
Source: REHDA Institute (2018)

During the Developer's Management Period, the property developer is carrying big responsibility in setting up the property management structure for the property before the handover process. According to Section 9(2) of the Strata Management Act 2013, developers are responsible to manage and maintain the property, determine charges and sinking fund, insure the property adequately, comply with the regulations and orders from the local authority, preparing and maintaining a register of all parcels, maintain and audit the accounts, enforce by-laws, and do such things as may be expedient or necessary for the proper maintenance and management of the building and land (Strata Management Act 2013 (Act 757). Section 9(3) of the act also gives the developers the power to impose charges and sinking funds as maintenance collections, authorize the expenditures necessary for management and maintenance, recover any necessary expenditures from the parcel owners and do any necessary things to perform their duties according to the act.

The is holding huge liabilities during the Developer's Management Period because stated in Section 9(5) and Section 10(7) of Act 757, if the developers fail to comply with provisions of the act or commit an offence, on conviction, will liable to a fine not exceeding two hundred and fifty thousand ringgit and imprisonment for a term not exceeding three years or both (Strata Management Act 2013 (Act 757).

Although the Developer's Management Period should be only for twelve months with a property hand-over period of an additional one month, the property developer is exposed to numerous risks. It is because the developer is an entity that is subject to the laws, which may sue and be sued in its name. There are risks for the property developer while executing its duties to manage the property. Hence, the developer must manage any risks relating to the property and its organisation as well. Knowing the risks would prepare the developer with the mitigation plans to ensure quality service to strata residents, retain the investment value of the property and protect the developer's interests.

Risks in Property Management

Property can serve multiple intentions because it holds rights, protects the interests and produces benefits. People usually link the property with the investment values which could provide varying returns on average between 4% and 8% depending on various market factors (Chai, 2021). But aside from monetary values, people would also invest in life quality by occupying comfortable properties. So, people would hope for the property manager to provide excellent property management services.

Considering the environment of newly completed strata property, which is still under the Developer's Management Period, this paper has identified the following risks that possibly affect the operation of strata management by the property developers.

Employees' Competencies

Inevitably, the business environment is currently facing a riskier operating environment due to globalization, technology and competition (Azreen Roslan *et al.*, 2017). Thus, requiring competent people to involve in property management services because demand for management and technical skills to deliver the service. The drop in employees' performance level becomes a risk for the organisation when they are affected by multiple factors originating from their working place (Kamarulzaman *et al.*, 2011). Overhauling of the working environment and correction actions by way of supervision, competency training, skill upgrading and development as well as employee engagement programs would be part of the solutions (Mohd *et al.*, 2020; Sabir Ahmad *et. al.*, 2021).

Liquidity

Liquidity is referring to the ratio between assets and liabilities owned by an organisation (Nur Hazimah Amran & Wahida Ahmad, 2017). In property management, financial liquidity would be an issue when the property manager does not have enough collections to meet the expenditures due to a shortage of collections or revenues, big cash outflows, long outstanding receivables and low returns on equity. Poor collection of service charges and the sinking fund would always be the main reason for liquidity issues for strata properties (Mohd Tawil *et al.*, 2012). It is eminent that the liquidity risk could be higher for the newly completed strata properties due to the mismatches between forecasted cash flow and actual cash flow due to inaccurate budgeting, unforeseen expenditures and the low number of occupants to pay the service charges during the early stages.

Non-Compliance with the Laws

Non-compliance to the law might happen in managing strata properties because there are so many regulations to comply with. Inexperienced developers may be facing difficulties to be well-versed with every law relating to strata management. Non-compliance usually originates from the failure of instilling good governance, irresponsible parcel owners' behaviour, vandalism, damages, housing features, environment and changes in technology or standard specifications (Azmi *et al.*, 2021; Rabe *et al.*, 2021; Shuhaimi *et al.*, 2022). The situation will give impact people's confidence and comfort to live in the property. In the worst situation, the developer is possibly facing legal charges because some of the rules are mandatory and would punish the offenders.

Litigation

Any COBs in the country are regularly receiving complaints from the parcel owners, developers, JMBs and MCs regarding the conduct of meetings and elections, administration matters, offences and many others (Cawangan Pengurusan Strata, 2019). COBs are also received many complaints about the misconduct by developers who manage the property. Although it can be argued that litigations involving the developer are increasing in parallel with the increased number of strata-titled properties (Christudason, 2007), the introduction of the Strata Management (Compounding of Offences) Regulations 2019 has shown the seriousness to do enforcement of strata management. Developers or any management body must fulfil the duties accordingly with good governance.

Customer Service

Without a doubt, property management is very much service oriented where the service provider must ensure clients' satisfaction. Excellent customer service will increase the reputation of the service provider and obtain loyalty from the customer (Andrew *et al.*, 2021). So, addressing all the issues in the strata property such as the complaints, damages and inadequate facilities would increase the residents' satisfaction (Rabe *et al.*, 2021). This area might pose some challenges to the developer to address the issues and handle them well. Especially when the developer has a wrong attitude about their short stint of existence in the property.

Security Management

Security is part of managing people's well-being and quality of life (Azmi et al., 2021). It gives assurance to make the environment in the property safe, thus would make people comfortable and trust. Implementation of good security management will promote good physical health, psychology, and wealth (Muhammad Azib & Farah Safura, 2022). Property developers must ensure the safety of the property by employing proper security guidelines and procedures.

METHODOLOGY

This study was adopting a qualitative approach in its research design. It was mainly using documents and semi-structured interviews to retrieve the information. From the documents and interviews, this study then adopted content analysis and thematic analysis to analyse the information. Reference to the documents has been made by inspecting relevant statutes and published documents from the authorities. The literature has helped the study to identify six related risk factors, which are fundamental to designing the interview questions. Two informants were interviewed after being satisfied with their backgrounds. During the interviews, both informants were still working with property developers and have relevant experience of more than 10 years in managing properties and were involved in setting up the property management for newly completed strata properties during the Developer's Management Period.

FINDINGS

Information from both of the informants is presented in Table 2. It presents the risks that the developers would face in managing strata properties during the Developer's Management Period together with their root causes. It confirms the risks identified in the literature and strengthens the discussions.

Table 2: Findings from the Interviews

Risks	Informant A	Informant B
Employees' Competencies	• Company growth was not in tandem with the workforce capacity & skill set. • The performance appraisal system was contrary to the operational needs. • Weak integration between internal learning and career development programmes.	• Ineffective training modules • Lack of continuous structured training • Ineffective internal knowledge transfer, sharing, coaching and handover. • The lackadaisical attitude among staff. • Flaws in standard operating procedures ("SOP") for property management
Liquidity	• Outstanding service charge and sinking fund	• Ineffective budgetary control due to staffing issues and documentation. • Ineffective supervision and credit monitoring procedures
Non-Compliance with the Laws	• Inadequate knowledge and awareness of regulatory and statutory provisions. • Lack of compliance status	• Incomplete and inaccurate disclosure of information to the regulatory bodies. • Errors in documents before

	monitoring. • Internal process weaknesses among departments in compilation and reporting to the regulatory bodies.	submission to regulatory bodies or agencies.
Litigation	• Delay in delivery of vacant possession to the purchasers resulting in dissatisfaction. • Unresolved disputes and delay in handling issues highlighted by the external party. • Breaching of the contract due to contract administration weaknesses and misunderstanding of the critical contract terms.	• Authorization issue in contract execution. • Lack of integrity • Non-payment issue due to creditor's credit terms. • Failure to diligently / meticulously vet through documents before submission to regulatory bodies/agencies.
Customer Service	• Delays in handling customers' complaints or queries.	• Analysis and investigation were not performed timely on customer complaints due to insufficient resources. • Misinformation and lack of concern by the staff. • Poor defect rectification and delay in defect remedial works.
Security Management	• Lack of skills, guidelines and SOP in security management • Insufficient surveillance system • Weaknesses in security management	• Inadequate physical access controls. • Inadequate security patrol • Lapses of verification on the security patrolling system.

The findings have revealed the root causes for all the identified risk factors relating to property management for the new strata properties. Both informants pointed out the root causes for each of the risk factors and elaborated on them all. For them, property developers should take the initiatives to identify the risks and find a mitigation plan. It will be a threat for the developers to manage strata properties without understanding the risks that they are facing. So knowing the risks and preparing the action plans would save the property developers and building occupants in unfavourable situations. Also, property developers should be more cautious about the regulations and requirements set by regulatory bodies and agencies. The informants agreed that most of the risks are internal, but need a proper strategy to address and mitigate them. Developer's Management Period is a critical phase for the property developer to fully completed their development project, so it must be taken highly.

CONCLUSION

Developer's Management Period demands commitments from the property developers to carefully plan and execute the property management set-up for the property. The process is tedious and quite risk-taking because so many decisions and works need to do. A smooth transition from property developer to JMB and MC can only happen when all the processes and procedures were carefully followed and good work coordination between the stakeholders.

This study has successfully identified six risk factors that developers should look into in managing strata-titled properties. The risks of employees' competencies, financial liquidity, non-compliance to the laws, litigation, customer service and security management must be seen as crucial to safeguard the interest of the parcel owners and the property developer itself.

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