JOURNAL OF THE MALAYSIAN INSTITUTE OF PLANNERS

PLANNING MALAYSIA

This title is now indexed in Scopus

MALAYSIA INSTITUTE OF PLANNERS
PLANNING MALAYSIA VOLUME 21 ISSUE 5 (2023)
[ISSN 1675-6215] e-ISSN 0128-0945]
www.planningmalaysia.org

PLANNING MALAYSIA

Journal of the Malaysian Institute of Planners

Editorial & Business Correspondence
PLANNING MALAYSIA
Journal of the Malaysian Institute of Planners
B-01-02, Jalan SS7/13B, Aman Seri, Kelana Jaya
47301, Petaling Jaya, Selangor Darul Ehsan, MALAYSIA
Tel: +603 78770637 Fax: +603 78779636 Email: mip@mip.org.my
www.planningmalaysia.org

This journal is a refereed journal.
All articles were reviewed by two or three unanimous referees identified by the Institute (MIP).

Published By
Malaysian Institute of Planners

ISSN Number
1675-6215
e-ISSN
0128-0945

Date Published: 29th September 2023

CONTENTS

MIP Council Members
2023 - 2025 Session

President
Datin TPr. Hjh Noraida Saludin (468/02)

Immediate Past President
TPr. Hj Ihsan Zainal Mokhtar (305/94)

Vice President
TPr. Hj. Abdul Hamid Akub (450/01)
TPr. Wan Andery Wan Mahmood (572/10)

Honorary Secretary
TPr. Juwairiyah Ho Abdullah (453/02)

Honorary Treasury
Datin TPr. Mazrina Dato' Abdul Khalid (559/09)

Council Members
TPr. Mohamad Fauzi Ahmad (418/99)
TPr. Abdul Halim Ali Hassan (407/98)
TPr. Saiful Azman Abdul Rashid (474/03)
Asst. Prof. TPr. Dr. Syafiee Shuid (813/21)
TPr. Hj Nik Mohd Ruiz Ahmad Fakhrul Razy (570/10)
TPr. Rene Fu Swee Yun (553/99)
TPr. Dr. Marlyana Azyyati Marzukhi (582/11)
TPr. Annie Syazrin Ismail (670/17)
TPr. Diyanah Inani Azmi (839/22)
TPr. Young Elias Young Daud (815/21)

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 1 – 16

CLIMATE VARIABILITY IN RELATION TO LAND USE AND LAND COVER (LULC) CHANGES IN KOTA BHARU, KELANTAN, MALAYSIA

Balqis Ibrahim[1], Zulfa Hanan Ash'aari[2]

[1,2] *Department of Environment, Faculty of Forestry and Environment,*
UNIVERSITI PUTRA MALAYSIA

Abstract

The process of rapid urbanization has significantly altered natural landscapes and contributed to climate variability. Due to urbanization, land surface characteristics are changing, resulting in a changing thermal climate making cities warmer than surrounding rural areas. The study utilized remote sensing and Geographic Information System (GIS) technologies to analyze the connection between land use and land cover (LULC) change and climatic variability in Kota Bharu, Kelantan, Malaysia. The outcome showed that the greatest LULC change resulted from converting vegetation and bare land into built-up areas, with 25.46% and 10.17% respectively. This represents the rapid expansion of urban land caused by population growth. LST increment averaged 3.65°C in the last decade due to this massive increase in built-up areas. A linear regression analysis between LST and LULC indices, NDBI and NDVI shows that they are positively correlated. By understanding these two variables, land use planning could be further improved, hence, reducing the city's vulnerability towards climate variability.

Keywords: Change detection, Geospatial analysis, Land change, Supervised classification

[2] Senior Lecturer at Universiti Putra Malaysia. Email: zulfa@upm.edu.my

INTRODUCTION

Climate change is widely recognized as one of the most severe issues confronting humankind and nature. It is a driver of the global crisis that affects every facet of our lives and future. The Intergovernmental Panel on Climate Change (IPCC)'s Fifth Assessment reported that the global average surface temperature rose 0.85°C from 1880 to 2012. It is expected to rise from 2.6°C to 4.8°C by the end of the 21st century (2081–2100) compared to the year 1986 to 2005 under high-emission scenarios (IPCC, 2014). Recent studies show that rapid urbanization that takes place in cities drives climate change (How Jin Aik, Ismail, & Muharam, 2020; Ibrahim, 2020; Alzubade, Ozcan, Musaoglu, & Türkeş, 2021). Urbanization has a number of negative effects, one of which is the modification of the thermal climate, which makes cities warmer than their rural surroundings (Rawat, Biswas, & Kumar, 2013).

The rising temperature (Kwan, Tangang, & Juneng, 2013; Moomaw et al., 2018) and an erratic rainfall trend are Malaysia's most visible climate changes (Khan, Shaari, Nahar, Baten, & Nazaruddin, 2014; Md Saad et al., 2023). According to Rahman (2018), Malaysia is estimated to be hotter by 2050, with a temperature increase of up to 1.5°C compared to just 0.6 °C over the past 28 years (World Bank, 2020). The use of satellite Remote Sensing (RS) and Geographical Information System (GIS) technology to analyze LULC transitions and hydrology purposes has been widely accepted (Khan et al., 2014; Latif & Kamsan, 2018; Zhou, Zhang, & Guo, 2019). As a result, analyzing the spatio-temporal changes in LULC has become one of the most important research topics in recent decades (Khan et al., 2014).

This study is intended to focus on whether there is valid evidence on climate variability in association with LULC alteration in the study area. The outcome of this study is expected to be essential for effective land use management and sustainable urban planning of the area, bringing awareness to the authorities and residents to make wiser decisions on land use.

RESEARCH METHODOLOGY

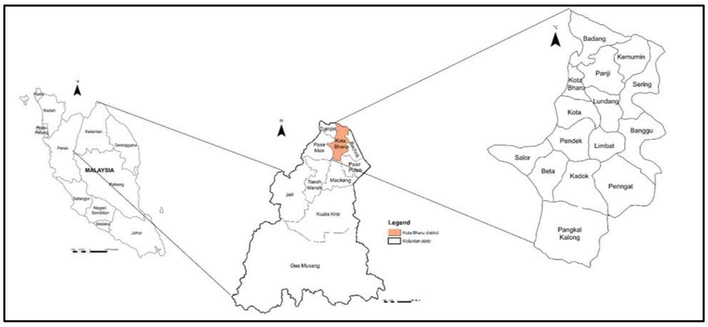


Figure 1: Geographical location of Kota Bharu district in Malaysia

Located on the east coast of peninsular Malaysia, Kelantan has a total area of approximately 15,100 km^2. The study area of Kota Bharu (Figure 1) is the capital city and major urban centre of the state that is in the northern part of Kelantan where the state's commercial and administrative hub is located. It has a typical tropical climate pattern, with an annual precipitation of 2500 mm and a mean temperature of 27.5 ºC (Tan, Ibrahim, Yusop, Chua, & Chan, 2017). Having a high-temperature increase (Ibrahim, 2020), the city is becoming increasingly vulnerable to natural disasters and temperature shifts due to its geographical characteristics, unplanned urbanization, and proximity to the sea (Faizalhakim et al., 2017).

Data Acquisition

This research is conducted using the satellite images of Kota Bharu from the year 1990 until 2020 which were obtained from the official website of the United States Geological Survey (USGS) https://earthexplorer.usgs.gov. The data were derived from Landsat 5 TM, Landsat 7 ETM+, and Landsat 8. Due to its availability and extensive coverage (How Jin Aik, Ismail, & Muharam, 2020), the Landsat imagery was chosen. The date of data that was taken was chosen based on the availability of data throughout the study year and region. Prior to the analysis, the satellite data were further screened for minimum cloud or haze coverage. As for climate variability, LST, which is estimated from the thermal emissivity of land surfaces contained in remote sensing images, was used in this research to represent temperature. The LST is an excellent indicator of long-wave and incoming solar irradiance, which impacts all LULC classes (Alzubade, Ozcan, Musaoglu, & Türkeş, 2021).

Data Processing & Analysis

Image Classification & LULC change mapping

Satellite images extracted from Landsat 5 TM, Landsat 7 ETM+, and Landsat 8 were used for LULC classification. The supervised image classification and change detection were applied using remote sensing software. The use of remote sensing data for change detection was based on the understanding that changes in land cover result in changes in radiance values, which may be remotely measured (Jin Aik et al., 2020). The land use for each year was reclassified into several major land uses which are the bare land, vegetation area, urban area, and water bodies. To ensure the land cover was correctly assigned, Google Earth images were used as a cross-reference. The classification of LULC was mapped using ArcGIS 10.8 to observe and visualize the change. The multiple LULC classes of the research area were represented using the stratified random approach for the accuracy evaluation. The accuracy was evaluated using 100 pixels per category based on visual interpretation and ground truth data. The non-parametric Kappa test was also used to gauge the degree of categorization accuracy.

Land Surface Temperature

In this study, the LST value will be extracted through pixel-based calculation. The value of each pixel is calculated using 1:

$$Land\ Surface\ Temperature\ (°C) = (pixel\ value \times 0.02) - 273.15 \quad (1)$$

From 1990 to 2020, the mean value is determined by comparing the 30 years of monthly images. The monthly mean LST is then measured using a formula by Patel, Joshi, & Bhatt (2017) in which the number of 8-day images in each of a given month is divided by all non-zero occurrences in that month.

NDBI and NDVI Calculation

This index detects urban areas with higher reflectance in the shortwave-infrared (SWIR) region than in the near-infrared (NIR) region for NDBI. It is calculated by dividing the SWIR by the NIR (Equation (2)). The NDBI was originally developed to work with Landsat TM bands 5 and 4 (Zha, Gao, and Ni, 2003). It will, however, function with any multispectral sensor having a SWIR band of 1.55-1.75 µm and an NIR band of 0.76-0.9 µm.

$$NDBI = (SWIR - NIR)/(SWIR + NIR) \quad (2)$$

NDVI is calculated using two bands with high reflectance in the NIR spectrum and strong absorption in the red wavelength as shown in Equation (3) (Xue & Su, 2017). The NDVI scale runs from 1 to -1. The greatest NDVI value implies healthy vegetation, whereas the lowest NDVI value indicates a lack of vegetation (Osunmadewa, Gebrehiwot, Csaplovics, & Adeofun, 2018). Near-infrared wavelengths of the electromagnetic spectrum are used to calculate the NDVI, along with the red bands of the visible spectrum, which was proposed by Rouse (1974). It is calculated using an equation where NIR stands for near-infrared reflection, while RED stands for red reflection (Gessesse & Melesse, 2019). NIR and RED are the reflectance emitted by the satellite MSS Landsat 5 in the NIR band 7 and visible red band 5, respectively. The NIR band for TM and ETM+ sensors would be band 4, and the RED band is band 3. Lastly, with the OLI sensor, band 5 and band 4 are the NIR and RED bands, respectively (Aslanov et al., 2021). As a result, the following formula yields the NDVI:

$$NDVI = (NIR - RED)/(NIR + RED) \quad (3)$$

Climate variability

To define the climate variability of the study area, the temporal trend of the data was observed and analysed using the Man Kendall and Sen's Slope Estimator. The Man Kendall test is widely used to detect meteorological variable patterns (Saimi, Hamzah, Toriman, Jaafar, & Tajudin, 2020). It is a nonparametric test that can be used to find monotonic trends in a series of climate data (Mudelsee, 2019). Monthly and annual trend analyses were conducted to detect any significant climate patterns from the year 1990 until 2020. The Mann Kendall trend analysis generates three outputs that decide whether a trend occurs. A positive z-statistic value indicates an upward trend, while a negative z-statistic value indicates a downward trend. The pattern is considered significant if the p-value is less than 0.05 (95% confidence level) (Kamal, Ashaari, & Abdullah, 2019). Sen's Slope and ArcGIS 10.8 were used to know the magnitude of the trend per year and map the LST of the study area respectively.

The relationship between LULC and climate variability

In order to determine the relationship between LULC and climate variability, a linear correlation coefficient analysis was used. This analysis served to unveil the connection between LULC and climate variability. The determination of whether the relationship is positively or negatively correlated was based on the R^2 values.

RESULTS AND DISCUSSION

Land Use and Land Cover (LULC)

Table 1 summarizes the trend of LULC from 2000 to 2020 based on the four classes that are extracted from the Kota Bharu study area. When the study began initially in the year 1990, the percentage of the total study area was dominated by vegetation, covering 64.22% of the total study area, followed by bare land

(21.44%), built-up area (11.69%) and water bodies (2.39%). The trend was observed for all LULC classes from the year 1990 until 2020. Throughout the 30 years, the built-up area had been the most increased area, from 11.96% to 32.24%, totaling a total of 20.28% increment. The percentage of vegetation had also decreased from 64.22% to 49.92%, making up a total of 14.30% for 30 years. This is followed by bare land, which had been decreasing from 21.44% to 15.84%. In 30 years, the total area had decreased by 5.60%. Meanwhile, the water bodies have not been decreasing at the same rate as bare land or vegetation, but it still has a slight decrease of 0.35%.

Table 1: Area of the LULC classification for 1990, 2000, 2010, and 2020 map

	1990		**2000**		**2010**		**2020**	
	Area (km^2)	**%**	**Area (km^2)**	**%**	**Area (km^2)**	**%**	**Area (km^2)**	**%**
Built-up Area	48.37	11.96	104.02	25.73	105.97	26.21	130.33	32.24
Vegetation	259.64	64.22	250.72	62.01	244.86	60.56	201.85	49.92
Water Bodies	9.62	2.38	9.55	2.36	8.63	2.13	8.09	2.00
Bare land	86.69	21.44	40.02	9.90	44.86	11.10	64.05	15.84

Accuracy Assessment

The overall classification accuracy and kappa coefficient obtained for the LULC classification accuracy evaluation of the 1990, 2000, 2010, and 2020 data were used to measure the classification quality. As a whole, LULC categorization scores varied from 93% to 97.5% across the four years, The agreement index of Kappa ranged from 0.88 to 0.96 (Table 2). For the study region, these Kappa values for the four categorization findings are acceptable since they meet Anderson's (1976) classification scheme's minimal accuracy requirement of 85%.

Table 2: Accuracy assessment of the LULC classification in Kota Bharu, Kelantan

	1990	**2000**	**2010**	**2020**
Overall	95.00	93.75	96.25	97.50
Kappa	0.93	0.88	0.95	0.96

Land Use and Land Cover (LULC) Changes

For the period of 1990 to 2000 (Figure 2(a)), the LULC change patterns reveal that the vegetation area was converted into a built-up area that summed up to a total of 13.78%, followed by bare land to vegetation with 13.19%. Meanwhile, from 2000 to 2010 (Figure 2(b)), the greatest LULC change was for a built-up area to vegetation, with 10.12%. This may be due to the expansion of the paddy field in the area (Mahamud et al., 2019). It was closely followed by vegetation to built-up area and bare land conversions, with 9.82% and 8.44%, respectively. From 2010 to 2020 (Figure 2(c)), the largest percentage of LULC change can be seen as a result of vegetation conversion into a built-up area and bare land, with 33.23% and 21.18%, respectively, contributing to the highest percentage of LULC change over the years (Table 3).

Based on a LULC modelling study by Mahamud et al. (2019) in Kelantan, it is believed that Kelantan has undergone major changes in the past few decades such as the incrementing of built-up areas and a reduction in forest areas. The built-up areas are mainly in the northern part of the state, i.e., Kota Bharu has been expanding at a steady rate, and there has also been an increase of urban sprawl within the city. According to the simulated LULC 2025, sprawl development is also taking place, which should prompt local planners to map out the development in Kelantan, especially in the Kota Bharu area.

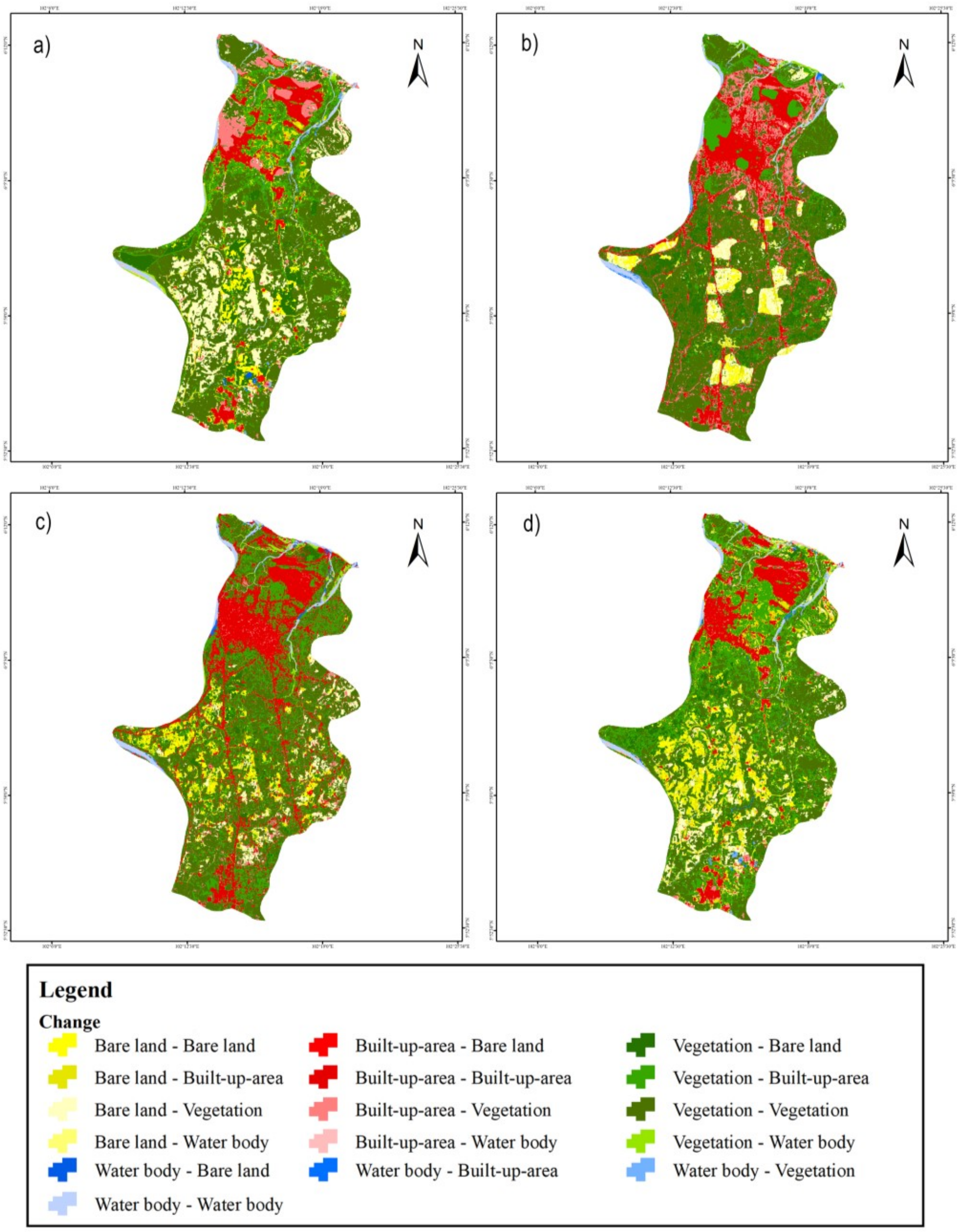


Figure 2: LULC Change Maps of Kota Bharu a) 1990-2000 b) 2000-2010 c) 2010-2020 d) 1990-2020

Table 3: LULC change area and percentage of Kota Bharu for the year 1990-2020

	1990-2000		**2000-2010**		**2010-2020**		**1990-2020**	
	Area (km^2)	**%**	**Area (km^2)**	**%**	**Area (km^2)**	**%**	**Area (km^2)**	**%**
Built-up area	28.10	6.96	59.56	14.74	84.58	20.93	40.91	10.13
Built-up area to Vegetation	17.95	4.44	40.88	10.12	13.33	3.30	4.51	1.12
Built-up area to Bare land	1.92	0.47	2.19	0.54	8.14	2.01	2.05	0.51
Built-up area to Water bodies	0.38	0.09	0.76	0.19	0.79	0.20	0.89	0.22
Vegetation	178.88	44.28	175.96	43.55	134.25	33.23	132.64	32.83
Vegetation to Built-up area	55.68	13.78	39.69	9.82	85.58	21.18	102.85	25.46
Vegetation to Bare land	24.88	6.16	34.08	8.44	19.99	4.95	22.59	5.59
Vegetation to Water bodies	1.98	0.49	1.80	0.45	4.25	1.05	3.30	0.82
Bare land	11.85	2.93	7.69	1.90	13.13	3.25	16.21	4.01
Bare land to Built-up area	19.07	4.72	6.88	1.71	14.36	3.55	41.06	10.16
Bare land to Vegetation	53.30	13.19	24.67	6.11	16.68	4.13	26.41	6.54
Bare land to Water bodies	0.52	0.13	0.38	0.09	0.13	0.03	1.06	0.26
Water bodies	6.61	1.64	5.90	1.46	6.59	1.63	6.47	1.60
Water bodies to Built-up area	0.53	0.13	0.69	0.17	1.42	0.35	1.10	0.27
Water bodies to Vegetation	1.42	0.35	2.56	0.63	0.76	0.19	1.47	0.36
Water bodies to Bare land	0.98	0.24	0.34	0.08	0.08	0.02	0.49	0.12

Normalized Difference Built-up Index (NDBI)

The NDBI density classes are inversely related to the green index. Higher values of NDBI are seen to be clustered around the built-up and bare land area (Figure 3). The NDBI values of each LULC class for each year are shown in Table 4.

Table 4: NDBI values of Kota Bharu in the years 1990, 2000, 2010, and 2020

	1990	**2000**	**2010**	**2020**
Waterbodies	-0.5897 - -0.2186	-0.6363 - -0.3171	-0.9285 - -0.2744	-0.5155 - -0.3253
Vegetation	-0.2186 - -0.0248	-0.3171 - -0.0566	-0.2744 - -0.0814	-0.3253- -0.2560
Bare land	-0.0248 - 0.1274	-0.0566 - 0.0645	-0.0816 - 0.1227	-0.2560 - -0.0937
Built-up area	0.1274 - 0.5789	0.0645 - 0.7142	0.1227 - 0.5774	0.1937 - 0.3380

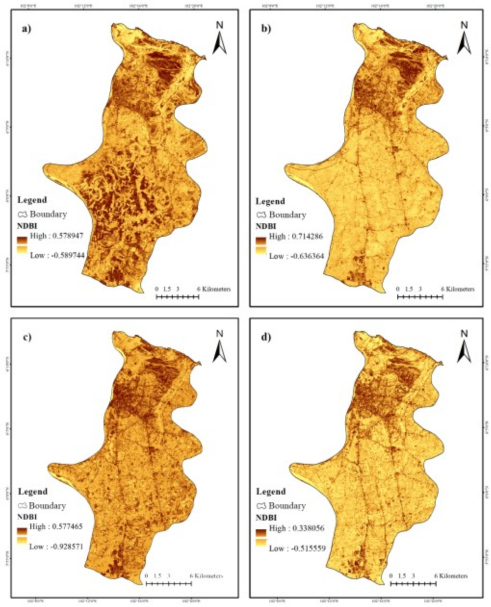


Figure 3: NDBI maps of a) 1990 b) 2000 c) 2010 and d) 2020 in Kota Bharu

Normalized Difference Vegetation Index (NDVI)

The expansion of lower NDVI values depicts the decrement of the vegetation area from 1990 to 2020 (Figure 4). The NDVI values ranged from 0.3498 - 0.7222 to 0.1773 - 0.4218. The waterbody has ranged from -0.4893 - -0.0474 in the year 1990 and ranged from -0.3331 - 0.0481 in the year 2020. Table 5 inputs the detailed NDVI values of each LULC class.

Table 5: NDVI values of Kota Bharu in the years 1990, 2000, 2010, and 2020

	1990	2000	2010	2020
Waterbodies	-0.4893 - -0.0474	-0.6999 - -0.0893	-0.7062 - -0.3562	-0.3331 - 0.0481
Vegetation	-0.0474 - 0.2541	-0.0893 - 0.3137	-0.3562 - -0.0964	0.0481 - 0.2501
Bare land	0.2541 - 0.3498	0.3137 - 0.5271	-0.0964 - 0.1451	0.2501 - 0.3773
Built-up area	0.3498 - 0.7222	0.5271 - 0.8117	0.1451 - 0.5838	0.1773 - 0.4218

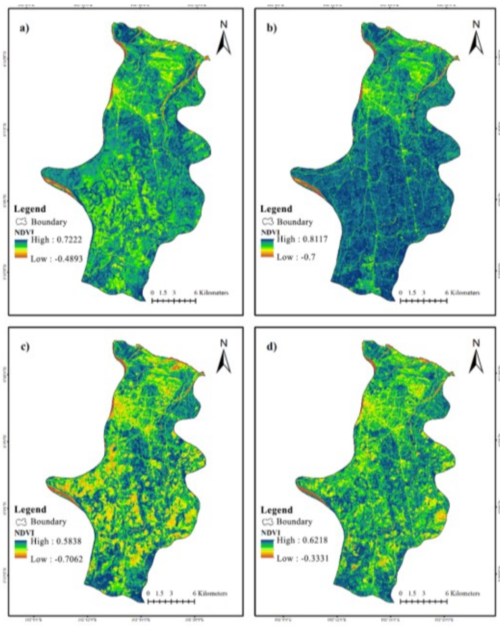


Figure 4: NDVI maps of a) 1990 b) 2000 c) 2010 and d) 2020 in Kota Bharu

Land Surface Temperature (LST)

Figure 5 illustrates the LST distribution in Kota Bharu. Throughout the 30 years, the maximum LST had decreased from 34.86°C to 29.19°C from 1990 to 2000, but continued to rise from 2000 until 2020, with the highest in 2020 at 35.70°C. The lowest minimum LST was 16.56°C in 1990. Over the last twenty years, the average LST has increased steadily from 22.62°C to 26.27°C, which is a 3.65°C rise. The highest LST values range near the city's urban area. As humans are heat carriers and contribute to the anthropogenic heat dispersion of the surrounding region, their presence in these locations has a substantial effect on the total LST. Known as thermal convection, this occurs when the heat rises while the cold air falls, and under massed settings, this heat is likely to attach to surrounding surfaces, such as those of buildings (Jin Aik et al., 2020). High NDBI values also indicate higher LST values and vice versa for the NDVI. Table 6 displays detailed temperatures of the study area.

Table 6: Average LST of Kota Bharu in the years 1990, 2000, 2010, and 2020

	1990	**2000**	**2010**	**2020**
Maximum ($°C$)	34.86	29.19	34.86	32.70
Minimum ($°C$)	16.56	17.33	18.38	20.17
Average ($°C$)	26.47	22.62	25.60	26.27
Maximum ($°C$)	34.86	29.19	34.86	32.70

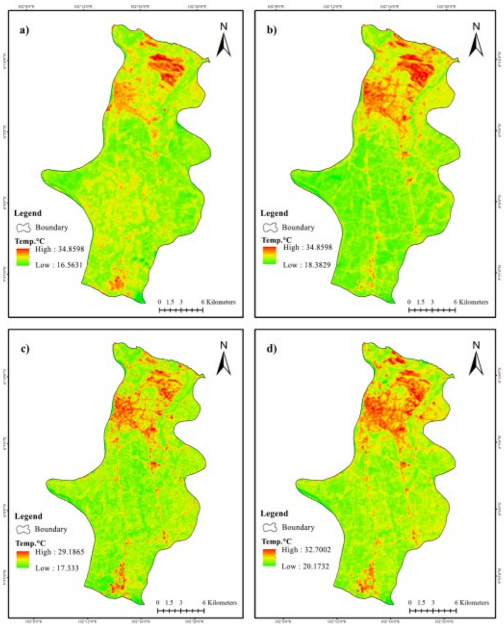


Figure 5: LST maps of a) 1990 b) 2000 c) 2010 and d) 2020 in Kota Bharu

Trend Analysis

The Mann-Kendall trend test analysis indicated the annual trend of LST in Kota Bharu. The Mann-Kendall test generates a positive result for the z-statistic. Based on the positive value, this implies that there is a strong increasing trend of the LST from 1990 to 2020. With a p-value of 0.0382, indicating that the result is statistically significant. Sen's Slope of 0.049 denotes the magnitude of the trend each year. In this scenario, the average annual increase is found to be 0.049°C per year (Table 7).

Table 7: Annual trend of Kota Bharu

	Z-statistic	P-value	Sen's Slope
Annual	1.0190	0.0382*	0.049

*Indicate statistically significant result

LULC change and LST relationship

To study the relation between the LULC indices and land surface temperature, 200 randomly selected sample points from LST, together with NDBI and NDVI data were applied to fit the regression and determine the Pearson correlation coefficients. The R^2 values provide insights into the strength and nature of the relationship between NDVI and LST, NDBI and LST for each respective year.

A regression analysis was performed for the years 1990, 2000, 2010, and 2020 between the LST and both LULC indices; NDBI and NDVI. For LST and NDBI, it reveals R^2 values of 0.4374, 0.6323, 0.5378, and 0.4994 for 1990, 2000, 2010, and 2020, respectively. Positive values show that the LST value rises in tandem with the NDBI values (Figure 6). The results indicate that the link between NDBI (urbanization or built-up areas) and LST suggests that as urbanization increases in an area, there is also a notable tendency for the land surface temperature to rise.

The NDVI-LST graph also showed a positive relationship. A regression analysis performed for the years 1990, 2000, 2010, and 2020 between the LST and the LULC index; the NDVI, reveals R^2 values of 0.3189, 0.3551, 0.1919, and 0.1428 respectively (Figure 7). This also suggests that there is a bidirectional relationship between them just as the NDBI-LST. LST can impact the phenology of vegetation and consequently, NDVI value. Conversely, variations in NDVI (vegetation changes) could also change LST such as a decrease in vegetation cover might lead to higher temperatures due to reduced shading and cooling effects of vegetation.

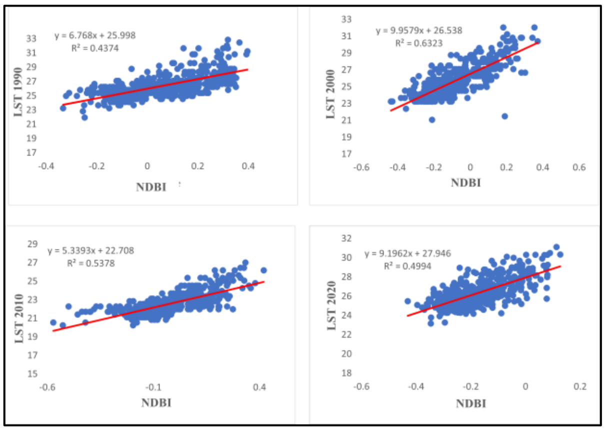


Figure 6: Regression analysis between NDBI and LST in Kota Bharu

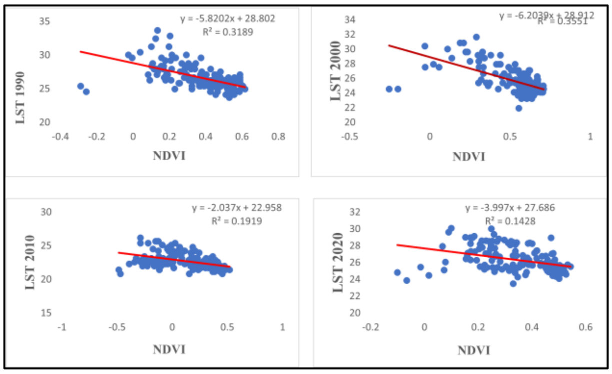


Figure 7: Regression analysis between NDVI and LST in Kota Bharu

CONCLUSION

A low-cost change analysis based on remote sensing data was conducted in Kota Bharu, Kelantan, to quantify and map the changing patterns of LULC using remote sensing data. The analysis and mapping of LULC in Kota Bharu laid the groundwork for strategic planning, management, and decision-making. However, multispectral satellite imagery with very high resolution would allow for more accurate details about the changes in the area.

According to the findings, most LULCs were converted into built-up areas between 1990 and 2020. The expansion of urban land is a result of vast population growth, as evidenced by the expansion of urban land in Kota Bharu. This region is a popular place to live because it is connected to other desirable cities such as Bachok, Tumpat, and Pasir Mas. During the observed period, there was also a 14.30% loss of vegetation and a 5.60% decrease in bare land for future development. The relationship between LULC and LST can be emphasized as how surfaces with high albedo and low absorptivity reflect heat, contributing to regional climate variability. A p-value of 0.0382 from the trend analysis for LST indicates that the result is statistically significant with an average annual increase of 0.049°C per year. The regression analysis results between the LULC indices and the associated LST values support this claim. In general, the increase in temperature in Kota Bharu is found to be affected by changes in LULC, with a positive correlation between the LULC indices, NDBI and NDVI with LST. As a result, proper land management is required to reduce the city's vulnerability to climate variability. Although many more indices are available, only the specified LULC indices have been used in this study. The influencing elements that may alter LST in urban settings, such as building height, density, and material, as well as seasonal changes, have not been included as they are difficult to detect in spatial datasets.

REFERENCES

Alzubade, M., Ozcan, O., Musaoglu, N., & Türkeş, M. (2021). Observed impacts of climate variability on LULC in the Mesopotamia region. *Computers, Materials & Continua*, *67*(2), 2255–2269. doi:10.32604/cmc.2021.013565

Anderson, J. R., Hardy, E. E., Roach, J. T., & Witmer, R. E. (1976). A land use and land cover classification system for use with remote sensor data. *Professional Paper*. doi:10.3133/pp964.

Aslanov, I., Mukhtorov, U., Mahsudov, R., Makhmudova, U., Alimova, S., Djurayeva, L., & Ibragimov, O. (2021). Applying remote sensing techniques to monitor green areas in Tashkent Uzbekistan. *E3S Web of Conferences*, *258*, 04012. doi:10.1051/e3sconf/202125804012.

Faizalhakim, A. S., Nurhidayu, S., Norizah, K., Shamsuddin, I., Hakeem, K. R., & Adnan, I. (2017). Climate variability in relation with land use changes over a 30-year period in Kelantan River Basin. *Malaysian Forester*, *80*(1), 12–30.

Gessesse, A. A., & Melesse, A. M. (2019). Temporal relationships between time series CHIRPS-rainfall estimation and eMODIS-NDVI satellite images in Amhara Region, Ethiopia. In A. M. Melesse, W. Abtew, & G. Senay (Eds.), *Extreme Hydrology and Climate Variability* (pp. 81–92). Elsevier.

How Jin Aik, D., Ismail, M. H., & Muharam, F. M. (2020). Land use/land cover changes and the relationship with land surface temperature using Landsat and MODIS imageries in Cameron Highlands, Malaysia. *Land*, *9*(10), 372. doi:10.3390/land9100372.

Ibrahim, M. H. (2020). Impact of urbanization on the formation of urban heat island in Kota Bharu, Kelantan. *Journal of Mechanics of Continua and Mathematical Sciences*, *spl9*(1). doi: 10.26782/jmcms.spl.9/2020.09.00007.

Intergovernmental Panel on Climate Change. (2014). *Climate change 2013 - The Physical Science Basis: Working Group I Contribution To The Fifth Assessment Report Of The Intergovernmental Panel On Climate Change* (Intergovernmental Panel on Climate Change, Ed.). Cambridge, England: Cambridge University Press.

Kamal, N. I. A., Ashaari, Z. H., & Abdullah, A. M. (2019). Spatio-temporal Variability of Heat Exposure in Peninsular Malaysia using Land Surface Temperature. *Disaster Advances*, *12*(12), 1–9.

Khan, M. M. A., Shaari, N., Nahar, A., Baten, M. A., & Nazaruddin, D. A. (2014). *Flood impact assessment in Kota Bharu, Malaysia: A statistical analysis*.

Kwan, M. S., Tangang, F. T., & Juneng, L. (2013). Projected Changes of Future Climate Extremes in Malaysia. *Sains Malaysiana*, *42*(8), 1051–1058.

Latif, Z. A., & Kamsan, M. E. S. (2018). Assessing the relationship of land use land cover on surface temperature in city of Shah Alam, Malaysia using landsat-8 oli. *Revue Des Sciences Fondamentales et Appliquees*, *9*(5S), 514. doi:10.4314/jfas.v9i5s.36

Mahamud, M. A., Samat, N., Tan, M. L., Chan, N. W., & Tew, Y. L. (2019). Prediction of future land use land cover changes of Kelantan, Malaysia. *ISPRS - International Archives of the Photogrammetry Remote Sensing and Spatial Information Sciences*, *XLII-4/W16*, 379–384. doi:10.5194/isprs-archives-xlii-4-w16-379-2019

Md Saad, M. H., Kamarudin, M. K. A., Toriman, M. E., Abd Wahab, N., Ata, F. M., Abu Samah, M. A., … Manoktong, S. N. (2023). Analysis of the flash flood event and rainfall distribution pattern on Relau River basin development, Penang, Malaysia. *PLANNING MALAYSIA JOURNAL*, *21*. doi:10.21837/pm.v21i25.1224

Moomaw, W. R., Chmura, G. L., Davies, G. T., Finlayson, C. M., Middleton, B. A., Natali, S. M., … Sutton-Grier, A. E. (2018). Wetlands in a changing climate: Science, policy and management. *Wetlands (Wilmington, N.C.)*, *38*(2), 183–205. doi:10.1007/s13157-018-1023-8

Mudelsee, M. (2019). Trend analysis of climate time series: A review of methods. *Earth-Science Reviews*, *190*, 310–322. doi:10.1016/j.earscirev.2018.12.005

Osunmadewa, B. A., Gebrehiwot, W. Z., Csaplovics, E., & Adeofun, O. C. (2018). Spatio-temporal monitoring of vegetation phenology in the dry sub-humid region of Nigeria using time series of AVHRR NDVI and TAMSAT datasets. *Open Geosciences*, *10*(1), 1–11. doi:10.1515/geo-2018-0001

Patel, S., Joshi, J. P., & Bhatt, B. (2017). An assessment of spatio-temporal variability of land surface temperature using MODIS data: A study of Gujarat state, India. Geography Compass, 11(4), e12312. doi:10.1111/gec3.12312

Rahman, H. A. (2018). Climate change scenarios in Malaysia: Engaging the public. *International Journal of Malay-Nusantara Studies*, *1*(2), 55–77.

Rawat, J. S., Biswas, V., & Kumar, M. (2013). Changes in land use/cover using geospatial techniques: A case study of Ramnagar town area, district Nainital, Uttarakhand, India. *Egyptian Journal of Remote Sensing and Space Sciences*, *16*(1), 111–117. doi:10.1016/j.ejrs.2013.04.002

Rouse, J. W., Jr, Haas, R. H., Schell, J. A., & Deering, D. W. (1974). *Monitoring vegetation systems in the Great Plains with ERTS*.

Saimi, F. M., Hamzah, F. M., Toriman, M. E., Jaafar, O., & Tajudin, H. (2020). Trend and linearity analysis of meteorological parameters in Peninsular Malaysia. *Sustainability*, *12*(22), 9533. doi:10.3390/su12229533

Tan, M. L., Ibrahim, A. L., Yusop, Z., Chua, V. P., & Chan, N. W. (2017). Climate change impacts under CMIP5 RCP scenarios on water resources of the Kelantan River Basin, Malaysia. *Atmospheric Research*, *189*, 1–10. doi:10.1016/j.atmosres.2017.01.008

Wan Ibrahim, W. Y., & Muhamad Ludin, A. N. (2016). Spatiotemporal land use and land cover change in major river basins in comprehensive development area. *PLANNING MALAYSIA JOURNAL*, (4). doi:10.21837/pm.v14i4.160

World Bank. (2020). *Turn Down the Heat: Why a 4°C Warmer World Must Be Avoided*. Washington, DC: Potsdam Institute for Climate Impact Research and Climate Analytics.

Xue, J., & Su, B. (2017). Significant remote sensing vegetation indices: A review of developments and applications. *Journal of Sensors*, *2017*, 1–17. doi:10.1155/2017/1353691

Zha, Y., Gao, J., & Ni, S. (2003). Use of normalized difference built-up index in automatically mapping urban areas from TM imagery. *International Journal of Remote Sensing*, *24*(3), 583–594. doi:10.1080/01431160304987

Zhou, S., Zhang, W., & Guo, Y. (2019). Impacts of climate and land-use changes on the hydrological processes in the Amur River Basin. *Water*, *12*(1), 76. doi:10.3390/w12010076

Received: 26th June 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 17 – 31

A QUALITATIVE STUDY ON THE DOCTRINE OF PRIVITY TO CIRCUMVENT ITS EFFECT ON SUBCONTRACTOR'S PAYMENT CLAIM

See Zhi Yan[1], Mohd Suhaimi Mohd-Danuri[2*], Noorfajri Ismail[3], Othman Mohamed[4], Fadzida Ismail[5]

[1,2,4]*Centre for Building, Construction & Tropical Architecture, Faculty of Built Environment,* UNIVERSITI MALAYA
[3]*Faculty of Syariah and Law,* UNIVERSITI SAINS ISLAM MALAYSIA
[5]*Faculty of Industrial Management,* UNIVERSITI MALAYSIA PAHANG

Abstract

In common law jurisdictions, the doctrine of privity has been criticised by the judiciary and academic commentators, particularly the second rule of doctrine, which states that a person who is not a party to the contract cannot sue on it to obtain promised performance, although the contract has been formed with the intention to benefit him. In certain circumstances, this rule may produce unfair and injustice result to the third party of a contract, as it prohibits the third party from enforcing the right to get benefits conferred on them. The doctrine of privity becomes relevant in the context of tendering procedures when subcontractors, who are not direct parties to the main construction contract, are involved. Hence, the aim of this paper is two-fold: to highlight the difficulties of the existing legal mechanism associated with privity rule and to suggest possible ways to circumvent the effect of the doctrine of privity on subcontractors' payment claims in the Malaysian construction industry. By adopting the socio legal research approach, the impact of the doctrine of privity, the difficulties of the existing legal mechanisms, and the need for a possible law reform were examined. The findings were also validated by conducting semi-structured interviews with five construction law experts. Among others, the findings showed that enhancement to the existing legal mechanisms and statutory intervention can effectively circumvent the privity rule and protect the subcontractor's right for the payment claim.

***Keyword*:** construction contract, doctrine of privity, subcontractor's payment claim, law of contract, legal mechanism

[2] Associate Professor at UM: msuhaimi@um.edu.my

INTRODUCTION

The doctrine of privity has been recognised as one of the most fundamental parts of contract law in the Malaysian construction industry. This doctrine stipulates that a third party who is not a party in a contract cannot be conferred any benefit, right, or obligation under a contract (Poole, 2006). The doctrine of privity consists of two general rules. The first rule is the third party who is not a party to a contract cannot be held liable or subjected to any responsibility. This first rule is completely uncontroversial. The focal point of this research was the second rule of the doctrine of privity, which states that a third party is unable to enforce a contract to gain the promised performance, even though the contract was made to benefit them (McKendrick, 2000). The privity rule is derived from the English private law, as demonstrated in the classic case of *Tweddle v Atkinson* (1861) ER 369. In this case, the plaintiff failed to act against the defendant, as he was a third party to the contract, which in consideration of the contract did not allow the stranger to take advantage of the contract, even though the contracting parties have intended to benefit the plaintiff.

In most construction projects, the third party involved in a construction contract is the subcontractor (Jimmie & Andrew, 1994; Haron & Arazmi, 2020). The main contractor is usually liable for the payment of the subcontractor under the subcontract, but the subcontractor would have to face serious problems in the event of the main contractor going into liquidation. Liquidation is also referred to as winding up, an inability of the company to pay its debt or becoming insolvent, which can lead to the dissolution of a company (Goode, 1990). In the case of the main contractor's liquidation, the subcontractor will become an unsecured creditor that has no priority to be paid based on the pari passu principle (Ng, 2006). Therefore, the subcontractor will generally try to claim the payment directly from the client. At this point, the subcontractor is unable to sue the client to obtain payment because of the absence of a contract between the client and the subcontractor, even though the client has accepted the work and goods provided. Consequently, critical issues would arise from the doctrine of privity against subcontractors.

The injustice and inconvenience resulting from an established application of the privity rule have led to the arising of arguments. According to Lord Diplock in *Swain v Law Society* [1983] 1 AC 598, privity rule is considered "an anachronistic shortcoming that has for many years been regarded as a reproach to English private law". Hence, several common law countries, which include England, Canada, and Australia have enacted legislations to reform the privity rule and protect third party rights under contract law. The legislation of Contracts (Rights of Third Parties) Act 1999 by the Parliament of the United Kingdom was implemented in England, Northern Ireland, and Wales as the most notable statutory exception to privity rule. It allows the third party to enforce the rights under a contract, if the contractual parties in the contract did not perform their obligation. In Malaysia's legal system, the privity rule is strongly embedded without a necessary legal reform despite the difficulties it has created, which can be proven by several law cases.

For instance, the cases of *University of Malaya v FBSM Ctech Sdn Bhd* [2018] 5 MLJ 397 and *MMC Oil & Gas Engineering Sdn Bhd v Tan Bock Kwee & Sons Sdn Bhd* [2016] 2 MLJ 428 have clearly stated that harsh and unanticipated impacts have been caused by the application of the privity rule to the subcontractors, who were the third party in these construction contracts. It was held by these courts that the subcontractors were unable to sue the clients to gain the promised performance, especially payment of the completed work, since there were no direct contractual links between them. The payment of a subcontractor is the responsibility of the main contractor because of the existence of a subcontract between them. The privity rule disallows the subcontractor from claiming the unpaid payment of works done directly to the client, if the main contractor goes into liquidation. Hence, it is an injustice to subcontractors to suffer economic loss when they have fulfilled their obligations and the client has received benefits from them.

To resolve the weakness of the privity rule, Malaysian courts have applied several circumventive mechanisms that could overcome the difficulties resulting from this doctrine. These mechanisms include collateral contracts, trust, agency, estoppel, assignment, and tort (Tan, 2009; Rosley et al., 2014). However, the effectiveness of these mechanisms remains a question. This paper presents the analysis findings of this socio-legal research on the application of these mechanisms, and the possibility of introducing a necessary statutory reform to effectively circumvent the effect of privity rule. This would mainly protect the subcontractor against the main contractor's payment default, as well as insolvency. The following section briefly describes the research methodology used in this study.

RESEARCH METHODOLOGY

A doctrinal study is qualitative in nature concerning the development of legal 'doctrines' based on the examination of legal norms (Chynoweth, 2008; M-Suaree et al., 2022). For centuries, the application of a doctrinal legal approach in a study has dominated areas of law. However, those who pioneered the socio-legal research field typically believe that we can only have a more complete picture of the law, if we adopt a more scientific view of it, not only through legal analysis but also via an empirical examination. Socio-legal methods are usually conducted through observations to describe the prominence of the "law in books" and "law in action". These observations can provide better understanding on the law through science and on the environment and society compared to doctrinal or pure legal research (Chynoweth, 2008; Mante, 2021; Mccrudden, 2006).

The impact of the doctrine of privity, the problems of the existing legal mechanisms, and the need for a legal reform were examined, specifically based on the construction industry. Previous judicial decisions were analysed to identify any underlying problems with the existing legal mechanisms. The operation of legislative enactments in other common law jurisdictions were also examined in overcoming the effect of the privity rule. These findings were then validated by conducting semi-structured interviews with five construction law experts. The participants selected for this research are experts in construction law and legal advisory roles in Malaysia. They possess extensive knowledge and specialized expertise in the domain of construction contracts. These individuals are well-versed construction law experts with the ability to offer valuable insights derived from their substantial involvement in Malaysian construction contracts.

ANALYSIS OF EXISTING LEGAL MECHANISMS TO CIRCUMVENT DOCTRINE OF PRIVITY

The following sub-sections present the analysis of existing legal mechanisms, namely, trust, estoppel, collateral contract, and assignment to circumvent the doctrine of privity, as well as the challenges and possible solutions based on the analysis of relevant judicial decisions with specific reference to Malaysian law cases.

Trust

The trust mechanism is one of the most widely used mechanism by Malaysian courts to circumvent the privity rule. The promisee acts as a trustee for a third party when the promisee enters a contract with the promisor (McKendrick, 2009). In the case of the promisor failing to perform their obligations, the third party may be able to recover their loss directly from the promisee. For example, in the case of *Malaysian Australian Finance v The Law Union & Rock Insurance Co Ltd* [1972] 2 MLJ, the appellant who was the owner of the tractor formed a contract with the hirer. The hirer then formed an insurance contract with the respondent, as promised under the contract with the appellant. Therefore, the owner was the third party to the insurance contract. The issue arose when the owner wanted to enforce the insurance contract to claim the loss. The court held that the owner can take legal actions against the respondent under the trust mechanism.

It would also be difficult for a subcontractor to claim payment from a main contractor who becomes insolvent. The common issue is whether, for instance, a claim related to retention monies or performance bonds, can be considered as trust monies. This has been clearly decided in the case of *Masai Tat Sdn Bhd v Sdn Bhd & Anor* [2020] MLJU 803, where the pari passu principle required all unsecured creditors in winding up processes to share equally any available assets of the company in liquidation. Hence, the subcontractor may only be able to claim the retention sum prior to other general creditors, if the contract formed between the main contractor and the employer has expressly stated that the retention money is held on trust for the subcontractor in the event of the main contractor's payment default. The requirement to have a clear provision of trust is also illustrated by several case law, as shown in Table 1.

Table 1: Summary of selected case law on trust

Case law	Decision of Court	Rationale of judgement
Qimonda Malaysia Sdn Bhd v Sediabena Sdn Bhd & Anor [2012] 3 MLJ 422	The Court of Appeal held that the retention money was held by the employer as trust monies for the contractor's beneficiaries impliedly.	The existence of the implied term in the construction contract that the retention sum was the trust money held by the main contractor for the benefit of the subcontractor.
Pembinaan Lagenda Unggul Sdn Bhd v Geohan Sdn Bhd [2018] MLJU 196	The Court of Appeal denied the fact that the retention sum can be deemed as the trust money.	There was no express term to prove the intention of both parties to create trust.
Pembinaan BLT Sdn Bhd v Portneka Sdn Bhd [2019] MLJU 811	The Court of Appeal denied the fact that the retention sum can be deemed as the trust money.	The failure to emanate retention monies from a contractor can be deemed as debt.
SK M&E Bersekutu Sdn Bhd v Pembinaan Legenda Unggul Sdn Bhd [2019] MLJU 211	The Federal Court stated that the trust was unable to be implied without the express term.	The Federal Court held that the express contractual term was needed to prove the formation of a valid trust.

Estoppel

Estoppel is an equitable principle articulated by the equity rule resulting from the unwillingness to acknowledge the good faith principle applied in establishing the legitimacy of a contract in common law (Asmadi & Nazir, 2020). It can be applied to prevent unfairness from occurring when the promisor denies the promise made and cause the promisee to suffer loss. Basically, estoppel is a legal principle that can prevent the contracting party from arguing the facts that are inconsistent with the previous statement or action made. In the construction industry, estoppel is invoked depending on the promise made. Generally, the estoppel principle is allowed to be invoked, if the court held that implementing the promise is the only way to avoid causing injustice to the person who made the promise.

One of the requirements that need to be fulfilled to apply the estoppel is the existence of a promise by way of an express term to avoid uncertainty (Lee et al., 2020). The promisee should also provide consideration, since the doctrine of estoppel can only be invoked by a third party, if it can be proven that the promise has been made by the promisor, or the contract has conferred benefit to the third party (Anida, 2013).

However, estoppel is said to be only a shield and not a sword in circumventing the privity rule, since it is deemed as an equity principle (Tan, 2009). In the case of *Combe v Combe* [1951] 2 KB 215, the court held that the estoppel was only allowed to raise a defence, since the consideration of the contract was applicable. The third-party beneficiaries would have been unprotected, if they simply depended on the estoppel principle. In addition, estoppel is usually unavailable against a liquidator, as shown in the following Table 2.

Table 2: Summary of selected case law on estoppel

Case law	*Decision of Court*	*Rationale of judgement*
Wong Chu Lai v Wong Ho Enterprise Sdn Bhd [2020] MLJU 76	The Court refused to allow the application of estoppel to the liquidator.	The estoppel could not operate against a liquidator, as it will interfere with his statutory power in investigating the debt, assets, and creditors of the company.
Perbadanan Perwira Harta Malaysia v Kuntum Melor Sdn Bhd [2021] MLJU 1593	The decision made in adjudication, which was relying on the estoppel, was set aside by the judicial commissioner.	The adjudicator failed to examine the merits of the appellant's defence and instead relied on the estoppel to ignore it.

Collateral Contract

The collateral contract is formed between the third party and the promisor in conjunction with the main contract entered by the promisor and promisee. The purpose of a collateral contract is to guarantee that the promisor will fulfil the promise in the main contract that is intended to benefit the third party (Tan, 2009). The effect of the doctrine of privity can be circumvented by the collateral contract, as the third party is allowed and entitled to take legal action against the promisor in case of a breach in the collateral contract. The collateral contract exists independently but it is related to the main contract (Seifi & Javad, 2018). The collateral contract should override any inconsistency with the main contract, and it should be amounted to promissory.

It is also important that the intention of the parties to create the collateral contract to be proven and the consideration to be provided by the third party. However, it is tedious and impractical to apply collateral contracts in large and complex construction projects because large numbers of collateral contracts are required by the involvement of many subcontractors and consultants in such projects. Furthermore, a collateral contract may not be a suitable mechanism to circumvent the privity of contract for recovering late or non-payment, if the main contract forms clearly states that there is no privity of contract between the client and the subcontractors, nominated subcontractors or suppliers, e.g., in Clause 62 of PWD203A (Rev.1/2010) and Clause 27.10 of PAM2018 (With/Without Quantities). Table 3 summarises relevant case law on collateral contract.

Table 3: Summary of selected case law on collateral contract

Case law	Decision of Court	Rationale of judgement
Bauer Sdn Bhd v Hundred Vision Construction Sdn Bhd & Anor [2020] MLJU 543	The High Court held that there was no independent liability of the employer to pay the subcontractor.	The liability of the employer to pay the subcontractor has been directly precluded by another clause in the collateral contract.
Tan Swee Hoe Co Ltd v Ali Hussain Bros [1980] 2 MLJ 16	The Federal Court held that the collateral contract can be valid.	The existence of the collateral contract has not violated the extrinsic evidence rule, that the oral promise was not incorporated into the primary contract.
KM Quarry Sdn Bhd v Ho Hup Construction Co Bhd [2006] 7 MLJ 203	The High Court held that the employer and the subcontractor were not in privity to each other.	The clause in the subcontract has stated that all the other clauses in the contract were unable to create the privity of contract between the employer and the subcontractor.
Y & Y Property Development Sdn Bhd v City-Lite Letrik Sdn Bhd [2015] 9 MLJ 411	The High Court has dismissed the application of the employer in this case by making a judgement that no arbitration agreement was established between the employer and the subcontractor.	The employer was unable to be deemed as a party to the subcontract by assumption and the subcontract has stated clearly that the subcontract was unable to create a privity of contract between the employer and the subcontractor.

Assignment

The assignment is generally applied by the contractor to assign the right of the subcontractor to be paid directly by the employer (Reza, Seyyed, & Mansour, 2019). An issue may arise when the employer argues that the assignment does not exist, and he is not liable to pay the subcontractor. The element to establish a valid assignment needs to be fulfilled so that the existence of the assignment can be implied. In this context, the party involved in the assignment and the benefit that must be assigned have to be ascertained. As shown in Table 4, the requirements of the assignment should be absolute and certain, which means that the assignor has the intention to transfer all or part of the right or beneficial interest to the assignee.

Table 4: Summary of selected case law for assignment

Case law	Decision of Court	Rationale of judgement
Boustead Naval Shipyard Sdn Bhd v Dynaforce Corp Sdn Bhd [2015] 1 MLJ 284	The Court of Appeal held that the assignment was unable to be invoked.	The parties involved in the assignment were not clearly stated and there was also an uncertainty in the letter issued.
Seagate Global Trading Sdn Bhd v Pelita Maintenance Resources Sdn Bhd & Ors [2019] MLJU 1002	The High Court made a judgement that the assignments between the parties were valid and absolute.	The deed of assignment exists in a written form with the consent of the second defendant, and all the rights and interest have been assigned absolutely by the first defendant to the plaintiff.

Figure 1 summarises the difficulties in dealing with the existing legal mechanisms and shows the proposed enhancement to the legal mechanisms to circumvent the effect of privity rule.

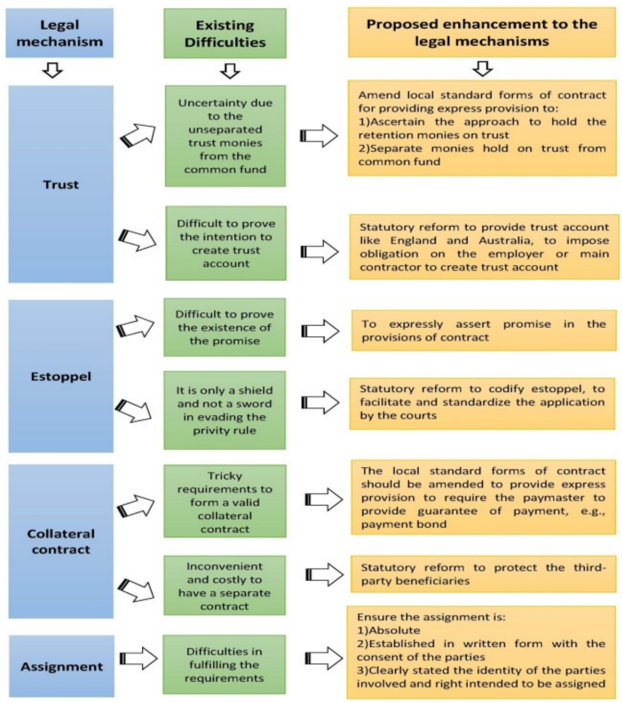


Figure 1: Analysis findings of the existing legal mechanisms to circumvent the effect of privity rule

LEGISLATIONS IN OTHER JURISDICTIONS TO CIRCUMVENT PRIVITY RULE

Criticisms towards the privity rule have led to the legislative enactments in several common law jurisdictions (Tan, 2009). The purpose of legislative enactments is to protect third-party rights and balance the justice within the parties involved in a contract. The following sub-sections briefly present the analysis findings of several legislative enactments in England and Australia, which are regarded as notable jurisdictions in evading the effect of privity rule.

Australia (Queensland) - Subcontractors' Charges Act 1974 (SCA 1974)

This legislation governs the right to secure payment from an employer for subcontractors by placing the onus on the employer to maintain a sufficient amount of money due to the main contractor until the court can make the decision, as stated in Section 11 of SCA 1974. It allows the subcontractor to claim the payment from the employer, if the main contractor defaults in payment or becomes insolvent. This legislation can create a direct legal liability between the employer and the subcontractor who are not in privity to the main contract. The requirements that need to be fulfilled to invoke SCA 1974 are a valid contract between the employer and the main contractor, and the payment claim must be the money yet to be paid by the employer to the main contractor. To claim the payment owed by the main contractor directly from the employer, the subcontractor is required to issue a notice of claim to the employer, and this notice becomes a statutory charge that allows the subcontractor to bypass the insolvency of the main contractor.

England - Contracts (Right of Third Parties) Act 1999 (CRTPA 1999)

This legislation changes the benefit rule by allowing a third party to enforce a statutory right, if the contracting parties fail to perform the contract. Section 1(1) of the CRTPA 1999 provides that a third party right will arise in a contract, if the contract expressly gives the right to a third party. Hence, for a subcontractor to have the right to claim payment directly from the client, the main contract between the client and the contractor must expressly provide the right to the subcontractor to claim directly from the client. However, such a third party right should be provided cautiously with a certain limitation, i.e., if the client has not paid the payment for the work to the main contractor, as to avoid double claim. CRTPA 1999 is not meant to abolish the effect of the privity doctrine but is subject to fulfilling the requirements of the legislation. Thus, the right of the third parties can be protected via statutory power, even though they are not in privity to the contract.

PROPOSED STATUTORY REFORM

The challenges in amending the standard forms of contract and unequal bargaining powers (i.e., the client or the main contractor dictates the use of a modified contract or contracts that are deemed siding to one of the parties) have raised the necessity of having a statutory intervention by way of statutory reform to appropriately circumvent the doctrine of privity. Generally, a statutory reform for the Malaysian legal system can be done via a general legislation or specific legislation. CRTPA 1999 in England is an example of a general legislation that can be introduced to provide a wider scope for protecting third-party rights for most types of contracts. However, this must be done cautiously, and the different types of third-party rights must be identified in the legislation, as to limit the main contracting parties' liability, namely, the client and the main contractor, against a third-party claim, e.g., the subcontractor's right to claim payment directly from the client because of the main contractor's insolvency.

A specific legislation could also address construction contract-related issues, e.g., application of the doctrine of privity and lack of security for payment. The Malaysian CIPAA 2012, for instance, is enacted to regulate the payment practice in the industry. According to Section 30 of CIPAA 2012, if the main contractor fails to pay the subcontractor, the subcontractor may use CIPAA 2012 to claim the payment directly from the employer, if there is money payable to the main contractor. However, this direct payment is only available to the subcontractor, if the parties have triggered adjudication under CIPAA 2012 and the main contractor fails to comply with the adjudicator's decision. Hence, a more rigorous approach is needed to effectively circumvent the effect of privity rule by way of amending the existing legislations, such as CIPAA 2012, to allow for protection of retention monies and the subcontractor's right to claim directly to the client, if the main contractor goes into liquidation. A new specific legislation could also be proposed to regulate all or certain aspects of the construction industry. In this regard, the SCA 1974 enacted in Queensland, Australia is a good example of a specific legislation that was introduced to allow subcontractors to claim payment directly from owners and to help secure the payment owed or due by giving priority of payment to the subcontractors ahead of any unsecured creditors.

An analysis of legislations in other jurisdictions have shown that the circumvention of the privity of contract is not a straightforward process. Unlike CIPAA 2012, which was intended to cover broader parties in regulating non-payment matters, e.g., main contractors, subcontractors, suppliers, and consultants, the present study proposed that any statutory reform for circumventing the privity of contract should properly address the identity of the third party and the type of right to be conferred. Hence, a more specific legislation like the SCA 1974 could be the best option to be adopted by the Malaysian construction industry to protect the subcontractor, especially against the main contractor's default in payment and in the event of the main contractor going into liquidation.

VALIDATION OF THE FINDINGS

For validation purposes, these experts were asked to validate the effectiveness of the proposed enhancement of legal mechanisms and statutory reform. The proposed statutory reform was also validated in terms of public interest, certainty, and justice based on their extensive experience and expert knowledge. Based on a study by Wan Azlina (2016), purposive sampling was adopted and 5 respondents have agreed to participate in the interview session to validate the findings. The respondents were approached through an online professional platform, LinkedIn. The respondents were selected based on their working experience, area of expertise, and position in their company, as shown on their LinkedIn profiles. Invitations to connect were sent to the potential experts with a short message. Subsequently, permissions to conduct interview sessions were sent in the chat box after they accepted the invitation to connect. The backgrounds of the respondents are listed in Table 5, while the validation results are provided in the following Table 6.

Table 5: Background of respondents

Respondent	R1	R2	R3	R4	R5
Gender	Female	Male	Female	Male	Male
Position in company	Lawyer/Legal Advisor	Lawyer	Lawyer/ Legal Advisor	Legal Counsel	Legal Advisor
Area of expertise	Construction Contract Management	Construction Disputes Resolution	Civil cases	Oil and Gas Industry	Construction Contract Management
Working experience	11 years	18 years	7 years	12 years	30 years

The respondents have shared their experience and opinions, and subsequently, offered some recommendations to overcome the challenges of the existing legal mechanisms to circumvent the effect of privity rule. Their recommendations were consistent with the analysis findings of the existing legal mechanisms to circumvent the doctrine of privity. These construction law experts generally agreed that the statutory mechanism would be necessary to circumvent the effect of privity rule. The feedbacks given by the respondents have shown that the proposed enhancement to the legal mechanisms and statutory reform can provide justice, certainty, and protect public interest.

Table 6: Findings of experts' validation

The effectiveness of the legal mechanisms to circumvent the effect of privity rule	
Trust	"…completely agree… that the separation of retention money from the general fund is required." (R1) "Need to write in the contract that the retention sum is held on trust." (R3) "…the court held that the retention sum should be held in a trust account for subcontractor beneficiaries." (R5)
Estoppel	"Yes, estoppel is also very inconvenient…need to state provision of direct payment from client to subcontractor expressly in the contract." (R1) "…can have legislation in relation to this." (R2) "…agree, the judicial decisions should be standardised." (R3)
Collateral contract	"…can enact legislation to force the client to issue guarantee." (R1) "Client wants to limit the liability, so it is hard to use collateral contract widely, unless there is a legislation that can force the client to do so…" (R2) "It would not be less effective than the contract, as long as the guarantee is given, then, it is enforceable." (R4)
Assignment	"…the only way is to fulfil the requirement…need to state who is going to receive the right…" (R2) "…need to specify what rights need to be assigned…" (R4) "…need to draft the deed of assignment in detail and get consent from both parties." (R5)
The effectiveness of the proposed statutory mechanisms	
In terms of public interest	"…can secure subcontractor payment, in the condition that the client did not pay the main contractor for that particular scope of work." (R1) "The subcontractor can be protected under the statutory reform, even if it has not been stated in the contract." (R2)
In terms of justice	"…can be fair because need to prove the consideration from the subcontractor…" (R1) "Legislation is fair to subcontractors; it enhances the existing position of the subcontractors and prevent them from suffering loss…" (R5)
In terms of certainty	"The proposed amendment can provide more clarity between client, main contractor, and subcontractor…" (R1) "Agree, it states the way to describe the third party clearly, whether all third parties include the sub-subcontractor or only the subcontractor…" (R2)

CONCLUSION

This research significantly contributes to the existing body of knowledge and serves as a valuable reference for future researchers. It achieves this by conducting a comprehensive study that examines the impact of the doctrine of privity within the context of the Malaysian legal system. Additionally, it delves into an analysis of the existing legal mechanisms within Malaysia while also considering legislative enactments in other common law countries. This multifaceted approach enhances the research's potential to inform and guide future studies in this field. The findings of this study have highlighted several possible enhancements to the existing legal mechanisms that could circumvent the effect of privity rule in the Malaysian legal system. The suggested enhancements could overcome the difficulties faced by the legal mechanisms by providing clarity and certainty that are needed to effectively circumvent the privity rule. It can be done, among others, by allowing a clear contractual provision that specifies the requirements for the retention money to be held in a trust account and explicitly provide the subcontractor with the right to claim direct payment from the client in case of the main contractor's insolvency. However, these suggestions should be approached cautiously without compromising the client's interest and other rights conferred in the main contract.

The doctrine of privity becomes relevant in the context of tendering procedures when subcontractors, who are not direct parties to the main construction contract, are involved. When subcontractors submit bids or proposals during the tendering process, they are typically not in a direct contractual relationship with the owner. Instead, their contractual relationship is usually with the main contractor. Hence, it is important to properly draft tendering and evaluation procedures to ensure compliance with contractual provisions, especially those designed to circumvent the privity rule. An in-depth study is required to identify critical issues related to contractor insolvency and financial problems, and how these issues have seriously affected the subcontractors and the construction industry. Such a study could justify whether a statutory reform to circumvent the effect of privity rule should be introduced and limited to the Malaysian construction industry, by way of legislating or reforming the existing legislation through a specific legislation approach.

ACKNOWLEDGEMENTS

The authors appreciatively acknowledge the grant provided by the Ministry of Higher Education Malaysia via the Fundamental Research Grant Scheme (FRGS/1/2019/SSI11/UM/02/3) (FRGS 2019-1)

REFERENCES

Andrew, K. & Les, R. (2008). *Advanced Research Methods in the Built Environment*. New York, NY: Wiley Blackwell

Anida, M. (2013). *The need for legislative reform of the privity doctrine in commercial contracts in Malaysia: A comparative analysis.* National University of Malaysia, Malaysia. Retrieved from https://eprints.qut.edu.au/64243/1/Anida_Mahmood_Thesis.pdf

Asmadi Mohd Angsor & Nazir Adi. (2020). The doctrine of promissory estoppel: As a shield or sword?. Research in Management of Technology and Business, 1(1), 918-925. Retrieved from https://publisher.uthm.edu.my/periodicals/index.php/rmtb/article/view/530

Chynoweth, P. (2008). Legal research. In A. Knight & L. Ruddock (Eds.), Advanced Research Methods in the Built Environment. Singapore Blackwell Publishing Ltd.

Goode, R. M. (1990). *Principles of Corporate Insolvency Law.* London, United Kingdom: Sweet & Maxwell.

Haron, R. C. & Arazmi, A. L. (2020). Late payment issues of subcontractors in Malaysian Construction Industry. *Planning Malaysia Journal, 18*(1).

Jimmie, H. & Andrew, T. (1994). The Contractor-Subcontractor Relationship: The Subcontractor's View. *Journal of Construction Engineering Management, 120*(2), 274-287.

Kiu, M. S., Chia, F. C. & Wong, P. F. (2022). Exploring the potentials of blockchain application in construction industry: a systematic review. International Journal of Construction Management, 22(15), 2931-2940.

Lee, K. H., Gan, S. Y., Mohd Danuri, M. S. & Zolkafli, U. K. (2020). Critical analysis of "Doctrine of Privity" in Malaysian construction industry. *Malaysian Construction Research Journal, 9*(1), 103-113.

Lee, S. (2019). Case Update: Federal Court Decides That Retention Sum in A Construction Contract is Not Held on Trust. Retrieved from https://themalaysianlawyer.com/2019/03/25/case-update-retention-sum-in-a-construction-contract-is-not-held-on-trust/

Mason, L. (2015). Enforcing contracts for the benefit of third parties: Recent reform of the doctrine of privity. Hong Kong Law Journal, 45(1), 13-28.

Mante, J. (2021). Understanding legal research in the built environment. In E. Manu & J. Akotia (Eds.), Secondary Research Methods in the Built Environment. New York: Routledge.

Mccrudden, C. (2006). Legal research and the social sciences. The Law Quarterly Review.

McKendrick, E. (2000). *Contract Law (Palgrave Law Masters).* (4th ed.). London, United Kingdom: Palgrave Macmillan.

M-Suaree, N. A. S., Syed Abdul Kader, S. Z., Mohamed-Osman, M., Abdul-Manaf, Z. (2022). The Development Of Policy And Legal Framework For Social Impact Assessment In Malaysia. Planning Malaysia Journal, 20(3), p.295-305.

Ng, S. H. (2006). *Legal position of the issues associated with main contractor's insolvency.* University Teknologi Malaysia, Malaysia. Retrieved from http://eprints.utm.my/id/eprint/2358/1/NgSockHooiMFAB2006.pdf

Orange, L. and Tree, J. (2014). Australia: Subcontractor's Charges Act - An (old) friend or foe? Retrieved from https://www.mondaq.com/australia/construction-planning/327438/subcontractor39s-charges-act--an-old-friend-or-foe

Poole, J. (2006). *Textbook on Contract Law.* (8th ed.). New York, NY: Oxford University Press.

Reza, N., Seyyed, S. & Mansour, A.A. (2019). Assignment of contract in forward sale of building Act. Private Law Research, 8(28), 285-308. Retrieved from https://jplr.atu.ac.ir/article_10476_en.html

Robert, K.Y. (2016). *Case Study Research: Design and Methods.* (4th ed.). Los Angeles: SAGE.

Rosley Sarah, Nazri Amalina, Ramlan Amalina & Ahmad Yossry. (2014). *Selected issues on the law of trust: a comparative study of judicial attitudes in Malaysia and United Kingdom.* University Teknologi MARA, Malaysia. Retrieved from https://ir.uitm.edu.my/id/eprint/31855

Seifi, Z. G. & Javad, P. (2018). Suspension in collateral contract. Journal of Law Research, 21(82), 205-226. Retrieved from https://lawresearchmagazine.sbu.ac.ir/article_58176.html

Tan, P. M. (2009). Circumventing the privity rule in Malaysia. *Journal of International Commercial Law and Technology, 4*(4). Retrieved from https://media.neliti.com/media/publications/28704-EN-circumventing-the-privity-rule-in-malaysia.pdf

Wan Azlina Binti Ibrahim. (2016). Regulatory framework for adjudicators in the Malaysian construction industry. University of Strathclyde, Scotland. Retrieved from https://stax.strath.ac.uk/downloads/1544bp28w

Received: 7th June 2023. Accepted: 5th September 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 32 – 47

MODEL OF PEDESTRIAN CROSSING BEHAVIOUR BASED ON ROAD TRAFFIC AND HUMAN FACTORS: A CASE STUDY OF MALAYSIA'S SHAH ALAM CITY

Na'asah Nasrudin[1], Nurul Shakila Khalid[2], Yusfida Ayu Abdullah[3], Marlyana Azzyati Marzukhi[4], Seng Boon Lim[5]

[1,2,3,4,] *Town Planning Studies, School of Town Planning and Landscape Architecture, College of Built Environment,*
UNIVERSITI TEKNOLOGI MARA PUNCAK ALAM
[5] *Programme of Town and Regional Planning, Department of Built Environment studies and Technology, College of Built Environment,*
UNIVERSITI TEKNOLOGI MARA PERAK BRANCH SERI ISKANDAR CAMPUS

Abstract

The present study intends to develop pedestrian crossing behaviour models based on road traffic and human factors. A questionnaire was distributed to 663 pedestrians in Shah Alam. Respondents were asked to complete a questionnaire regarding their risk perceptions and attitudes pertaining to walking and road crossings. This study identified two human factors that influenced pedestrian crossing behaviour: the "risk-taker" and the "rule-follower." The modelling analysis revealed a substantial correlation between human factors and crossing behaviour. Analysis of pedestrian crossing behaviour is useful to evaluate the implementation of novel pedestrian crossing environments. The study offers insights applicable to urban planning and policy approaches for reducing pedestrian accidents by utilising strategies such as extended signal timing, audible signals, countdown timers, and optimising intersection design to improve pedestrian safety.

Keywords: Pedestrian crossing; Pedestrian crossing behaviour; Human factors; Pedestrian behaviour

[1] Senior Lecturer at Universiti Teknologi MARA. Email: naasa717@uitm.edu.my

INTRODUCTION

Human factors associated with pedestrians have received less attention in the literature than those associated with the majority of other road users. However, it is also highlighted that road and traffic factors alone can only explain a minor portion of urban pedestrian and crossing behaviour. Comprehensive research has been conducted on pedestrian crossing behaviour in urban areas, which has provided beneficial insight into the roles of road, traffic, and pedestrian characteristics on pedestrian crossing decisions, their compliance with traffic rules, and related safety. Despite a significant emphasis on pedestrian behavioural studies, the correlation between pedestrian behaviour and human factors has been minimally explored. The present study aims to develop pedestrian crossing behaviour models based on road traffic and human factors. Specifically, the objective of this study is to identify and analyse critical components influencing pedestrian walking and crossing behaviour, including pedestrians' attitudes, expectations, motives, behaviours, and habits based on these human factors.

LITERATURE REVIEW

The number of published articles on research on human factors in road and transportation design and the behaviours of road users is extensive (Fuller & Santos, 2002). Several studies have been conducted related to human factors in pedestrians' crossing behaviour using questionnaires or in-depth interviews. Evans and Norman (1998) developed hierarchical regression models for road crossing behaviour using a questionnaire as an instrument that included scenarios of three specific potentially dangerous road crossing behaviours. Earlier in 1996, Hine used in-depth interviews to discover pedestrians' perceptions and assessments of traffic conditions and crossing facilities in the city of Edinburgh. Yagil (2000) modelled pedestrian crossing behaviour concerning measures of attitude, subjective norm, perceived behavioural control, intention, and self-identity, subsequently proposing multivariate regression models of unsafe crossings relating to values, the consequences of the behaviour, instrumental and normative motives for compliance with safety rules, and situational factors by using respondents' self-reported frequency. Alternatively, Diaz (2002) developed a structural equation model for explaining pedestrian risk-taking behaviour based on attitude, subjective norm, behavioural intention, and reported violations, errors, and lapses.

Pedestrian behaviour is incredibly complex and influenced by environmental and urban design. Appropriate design of facilities will encourage walking without compromising safety and convenience (Shriver K., 1997). Waiting time and distance crossing (distance between the destination of the trip and the actual location of the crossing) are mainly external factors that may cause a dangerous crossing. The need to rush or the desire to keep moving along a shortcut is the main subjective reason behind the lack of compliance with pedestrian signals or crossing facilities. Pedestrian violations can be considered the predictable outcome of the contradiction between external factors and human factors. Chu et al. (2003) used data obtained from pedestrians' stated crossing preferences and explained them within the framework of disaggregate models. Yannis et al. (2007) improved Chu's model by evaluating accident risk along a trip based on the estimated crossing behaviour of pedestrians. Nassiri and Sajed (2009) assessed and identified the valid parameters in a pedestrian's decision-making process based upon vehicle speed and headway on multi-lane streets by using the logit model. Papadimitriou et al. (2013) revealed the statistical analysis of their study and discovered seven components of pedestrian attitudes and behaviour (formed based on 54 questionnaire elements). Based on the literature review, the human factors to be examined in the present research have been defined, and the specific question has been designed to be tested according to pedestrian perceptions, attitudes, beliefs, motivation, etc.

METHOD

The present study aims for the development of pedestrian crossing choice models based on road and traffic conditions. More specifically, it intends to develop choice models for estimating the probability of crossing at each location along a pedestrian's trip concerning roadway design, traffic flow, and traffic control. This paper also analyses pedestrian crossing behaviour based on pedestrians' gender and age group. The data used in this study was collected through a questionnaire survey of 663 pedestrians aged from 13 to 75 years old in eight different areas of Shah Alam City. The selected sample was calculated based on the total population, which is about 336590 people, with a 99% degree of confidence and a 5% margin of error. For the development of the questionnaire, several questionnaires were adapted from the existing literature. The questions were designed to be rated based on Likert-type scales, including responses like "always/never" or "agree/disagree". The questionnaire for this study was developed based on related crossing behaviour elements, such as perceptions, attitudes, beliefs, motivation, etc. The questionnaire includes four sections:

- Section A: Demographics
- Section B: Risk Perception, Attitudes, and Preferences (Human Factors)
- Section C: Pedestrian Crossing Behaviour
- Section D: Pedestrian Perceptions of Drivers

Field Survey Design

The field survey design consists of three walking conditions, and several places have been identified as survey areas according to these three crossing conditions.

- Crossing a main urban road with signal-controlled and uncontrolled crosswalks:
  For this particular crossing condition, Section 7, Shah Alam, has been identified as the survey area that involves UiTM students crossing the road to access commercial facilities near the campus. Besides that, crossing facilities near Shah Alam's Hospital have also been surveyed to measure the effectiveness of pedestrian crossing facilities and their relation to crossing behaviour.

- Crossing a minor (residential) road with or without marked crosswalks:
  Several schools located near residential areas have been chosen as the survey area, which includes Sections 6, 7, 9, 15, and 19. Besides that, locations that facilitate public transport have also been chosen as the survey area, such as Section 15 (Padang Jawa) and Section 19.

- Crossing a major urban arterial road with signal-controlled crosswalks:

For this particular crossing condition, a high-capacity urban road has been chosen as the study area, which involves a pedestrian crossing that accesses a bus station in Section 13, close to the Federal Highway. This pedestrian crossing is also being used to access AEON Mall.

Table 1: Study Areas with the Number of Populations and Sample Size

Locations	**Population**	**Sample Size**
Section 7 (Pusat Komersil Sek.7, KFC, McD)	37,415	100
Section 7 (SMK Section 7)		50
Section 7 (SK Section 7)		50
Section 13 (MSU)	2,075	100
Section 14 (PAS, PKNS, SACC)	City Centre	100
Section 16 (Padang Jawa, SK Padang Jawa)	5,355	60
Section 18 (Ole-Ole, Pusat Komersil)	10,320	100
Section 19 (KTM, SK Section 19, Integrated Islamic School)	10,900	103
Total	**66,065**	**663**

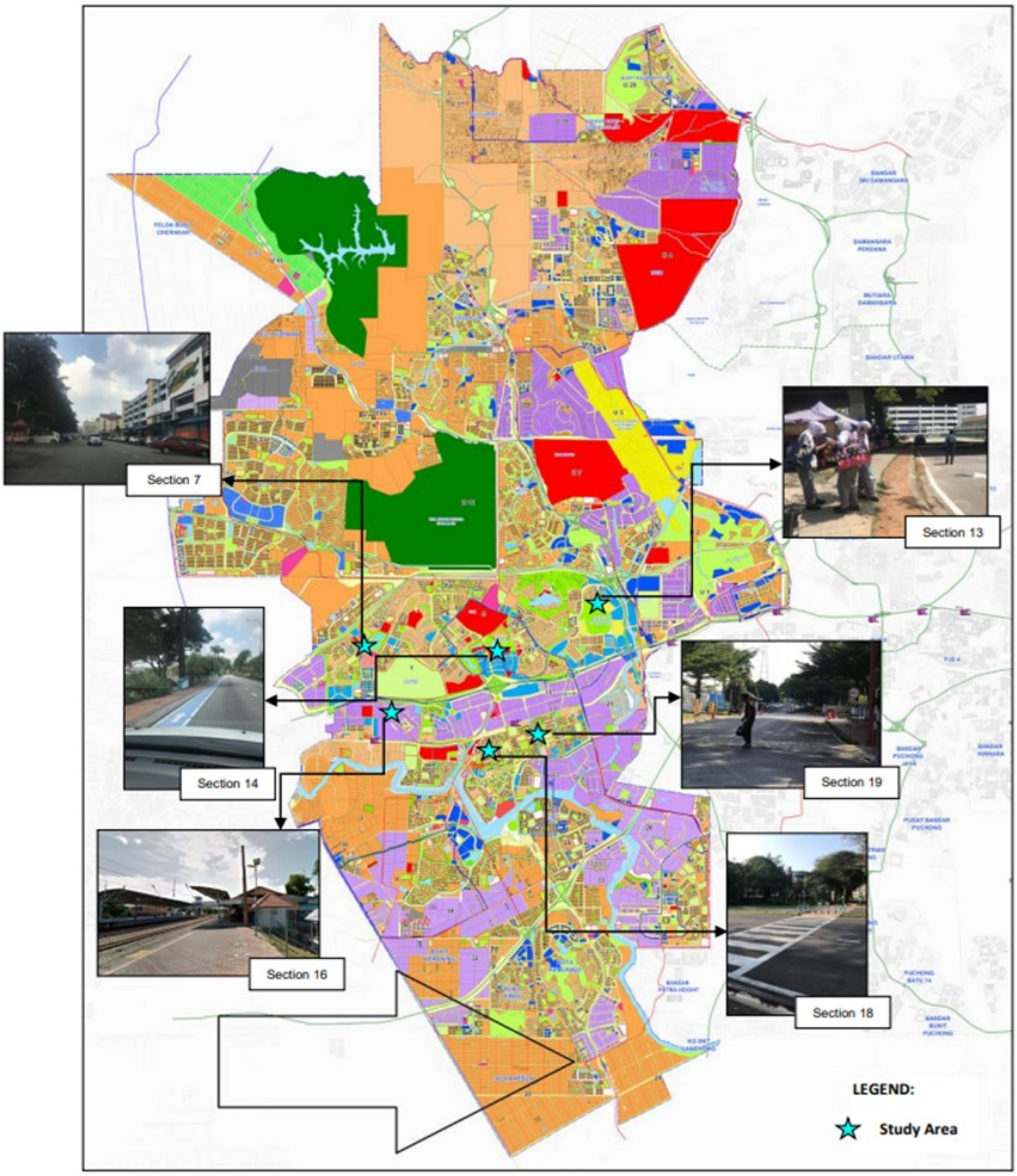


Figure 1: Location of Study Area

FINDINGS

Descriptive statistics

A survey was created and implemented to evaluate the assumptions specified in the study. Ultimately, a survey was created to ascertain respondents' perceptions, attitudes, and preferences pertaining to pedestrian crossing, including individuals' preferences and desire to walk. A number of behavioural and compliance-related inquiries were conducted, which were further supplemented with information from additional published surveys pertaining to perceptions, attitudes, beliefs, motivations, and associated factors (Evans & Norman, 1998; Bernhoft & Carstensen, 2008; Yagil, 2000; Sisiopiku & Akin, 2003).

Table 2: Attitudes and Preferences for Walking

Reasons for Walking	Frequency	Percentage
For short trips, I prefer to walk.	399	60.2
I have to walk because I am taking public transportation.	206	31.1
I walk because it is healthy.	186	28.1
I walk because I have no other choice.	150	22.6
I walk because it saves me time to arrive at my destination.	133	20.1
I walk to avoid traffic congestion.	111	16.7
I walk for the pleasure of it.	71	10.7

Table 2 shows that the majority of respondents prefer to walk on a short trip (60.2%). Most respondents did not give a positive travel motivation (e.g., health and pleasure purposes have low scores). More than one-third (31.1%) of the respondents' reported that they walked because they were taking public transportation. Azmi and Abdul Karim (2018), in their study, also found that people in urban areas, especially in Putrajaya and Shah Alam, are more likely to drive rather than walk. In terms of their willingness to walk, 41.2% of respondents said that the farthest distance they are willing to walk is less than 500 metres, followed by 37.7% who said that the farthest distance they are willing to walk is between 500 metres and 1 kilometre.

Table 3 summarises the responses on risk perceptions related to the road crossing, the value of time, and opportunistic behaviour, among others. Most pedestrians have positive attitudes and preferences (e.g., being risk-conscious and compliant), as they tend to agree that crossing roads outside designated locations is risky and illegal. However, the majority of pedestrians also agree that crossing roads outside designated locations saves time, and crossing roads outside designated locations is acceptable because other people do it.

Table 3: Distribution of Pedestrian Perceptions, Attitudes, and Preferences at the Pedestrian Crossing

		1	**2**	**3**	**4**	**5**	**Mean**
B_2	Crossing roads at designated locations reduces the risk of accidents.	1 0.2%	3 0.5%	56 8.4%	390 58.8%	213 32.1%	4.22
B_3	Crossing roads outside the designated locations is illegal.	8 1.2%	21 3.2%	112 16.9%	372 56.1%	150 22.6%	3.96
B_4	I prefer routes with signalized crosswalks.	1 0.2%	5 0.8%	113 17.0%	349 52.6%	195 29.4%	4.10
B_5	I try to make as few road crossings as possible.	2 0.3%	20 3.0%	111 16.7%	370 55.8%	160 24.1%	4.00
B_8	I am willing to take any opportunity to cross.	4 0.6%	19 2.9%	136 20.5%	308 46.5%	196 29.6%	4.02
B_9	Crossing roads outside the designated locations saves time.	4 0.6%	29 4.4%	167 25.2%	301 45.4%	162 24.4%	3.89
B_10	Crossing roads outside the designated locations is acceptable because other people do it.	9 1.4%	34 5.1%	161 24.3%	274 41.3%	185 27.9%	3.89

*1: strongly disagree; 2: disagree; 3: undecided; 4: agree and 5: strongly agree

Table 4 summarises the respondents' self-reported behaviour, compliance, and risk-taking. The result shows the majority of pedestrians have less positive behaviour when they choose "sometimes "in terms of crossing at a designated crosswalk. Even in situations where pedestrians are pressed for time and there is no approaching traffic or when vehicles are stationary due to traffic congestion, it is observed that a majority of pedestrians opt to cross the road at the designated crosswalk. Less than 5% reported that they never cross at a designated crosswalk on a major urban road.

Nevertheless, the majority of pedestrians responded that they "never" cross roads without paying any attention to traffic. The majority of respondents reported they "sometimes" cross roads even when the pedestrian signal light is red. They also "sometimes" cross designated crosswalks absent-mindedly, like talking on a cell phone or listening to music on headphones. It may be interesting to note that pedestrians report that they "often" cross at designated crosswalks when they see other people do so.

Table 4: Distribution of Pedestrian Behaviour, Compliance, and Risk-Taking

Pedestrian Crossing Behaviour		**Never**		**Rarely**		**Sometimes**		**Often**		**Always**	
		N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
C_1	I cross at a designated crosswalk when there is no oncoming traffic.	2	0.3	8	1.2	401	60.5	129	19.5	123	18.6
C_2	I cross at a designated crosswalk when I am in a hurry.	17	2.6	19	2.9	434	65.5	107	16.1	86	13.0
C_3	I cross at a designated crosswalk when there is a shop I like on the other side.	13	2.0	18	2.7	414	62.4	126	19.0	92	13.9
C_4	I cross even though the pedestrian light is red.	226	34.1	136	20.5	235	35.4	53	8.0	13	2.0
C_5	I cross between vehicles stopped on the roadway in traffic jams.	17	2.6	25	3.8	419	63.2	121	18.3	81	12.2
C_6	I cross without paying attention to traffic.	269	40.5	209	31.5	116	17.4	39	5.9	30	4.5
C_7	I am absent-minded while crossing.	65	9.8	52	7.8	374	56.4	99	14.9	73	11.0
C_8	I cross while talking on my cell phone.	58	8.7	40	6.0	390	58.8	99	14.9	76	11.5
C_9	I cross while listening to music on my headphones.	150	22.6	45	6.8	348	52.5	50	7.5	70	10.6
C_10	I cross even though obstacles (parked vehicles, buildings, trees, etc.) obstruct visibility.	33	5.0	24	3.6	384	57.9	158	23.8	64	9.7
C_11	I cross even though there are oncoming vehicles.	147	22.2	364	54.9	40	6.0	46	6.9	66	10.0
C_12	I cross at a designated crosswalk when I see other people do so.	13	2.0	20	3.0	178	26.8	381	57.5	71	10.7

C_13	I cross at a designated crosswalk when my company prompts me to do so.	35	5.3	75	11.3	245	37.0	219	33.0	89	13.4
C_14	I inspire my company to cross at a designated crosswalk.	25	3.8	65	9.8	240	36.2	205	30.9	128	19.3

Confirmatory Factor Analysis (CFA) in the Measurement Model

Table 5 shows the summary of confirmatory factor analysis (CFA) for every construct in the measurement model. Based on Table 4, the value of factor loading for each item is higher than 0.60. Item B6, B7, C4, C13, and C14 were deleted due to a low factor loading of less than 0.60. The requirement for unidimensionality was achieved through the item deletion procedure for low-factor loading items. The value of AVE obtained from every construct is higher than 0.50. Thus, convergent validity for the measurement model is achieved since all the values for AVE are higher than 0.50, as suggested by Fornell and Larcker (1981).

Table 5: Summary for Confirmatory Factor Analysis (CFA) in the Measurement Model

Construct	Component	Item	Factor Loading	CR	AVE
Human Factors	Component 1	B2	0.74	0.89	0.68
		B3	0.87		
		B4	0.81		
		B5	0.86		
	Component 2	B8	0.87	0.93	0.81
		B9	0.86		
		B10	0.96		
Crossing Behaviour	Component 1	C1	0.61	0.84	0.65
		C2	0.94		
		C3	0.83		
	Component 2	C6	0.93	0.95	0.87
		C7	0.91		
		C8	0.96		
	Component 3	C9	0.90	0.93	0.80
		C10	0.88		
		C11	0.91		

Based on Table 6, when the three Fitness index categories, namely Absolute Fit, Incremental Fit, and Parsimonious Fit, meet the requirements, construct validity is achieved. CFI is equal to 0.90 or higher, RMSEA is equal to 0.08 or lower, and the ratio of Chisq/df is less than 5.0.

Table 6: Summary for the Assessment of Fitness Indexes

Category	Fit	Recommended	Obtained	Comment
Absolute Fit	RMSEA	< 0.08	0.085	Satisfied
Incremental Fit	CFI	> 0.90	0.954	Achieved
Parsimonious Fit	Chisq/df	< 3.0	5.722	Satisfied

Reliability and Validity of the Measurement Model

For component validity, the value of AVE obtained from every construct is higher than 0.50. Thus, the convergent validity of the measurement model is achieved since all the values for AVE are greater than 0.50, as suggested by Fornell and Larcker (1981). In terms of reliability, a Cronbach's Alpha of 0.6 or higher for a component reflects the measuring items under that particular component and provides a reliable measure of internal consistency. Nunnaly (1978) suggested that the value of Cronbach's Alpha must be greater than 0.60. The value of Cronbach's Alpha for each construct in this study exceeded the minimum value of 0.6, as recommended by Nunally (1978). Therefore, internal reliability is achieved.

Relationship between Human Factors and Crossing Behaviour

Table 7 shows the standardised regression weight for the structural model. Based on the table, the path coefficient of human factors to the crossing behaviour is 0.49. This value indicates that for every one-unit increase in human factors, its effects will contribute an increase of 0.49 units in crossing behaviour since the p-value is less than 0.05 ($p = 0.0001 < 0.05$); therefore, it can be concluded that there is a significant relationship between human factors and crossing behaviour.

Table 7: Relationship between Human Factors and Crossing Behaviour

Path Coefficient	Estimate	P-value	Comment
Human Factors to Crossing Behaviour	0.49	0.0001	Significant

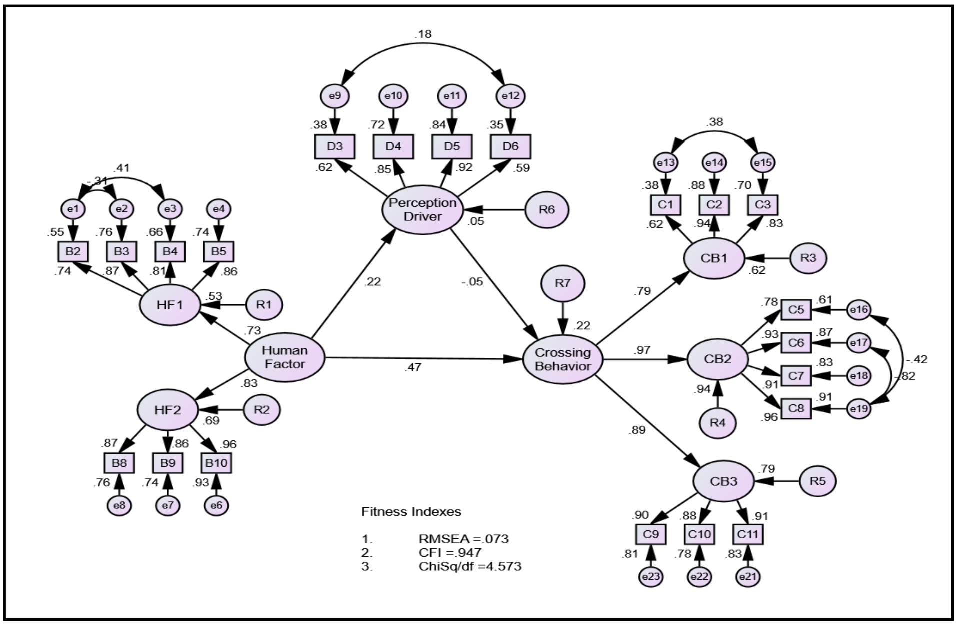


Figure 2: Structural Model

DISCUSSION

Contribution of the Human Factors Dimension to the Crossing Behaviour Model

The results of the modelling research indicated the presence of two distinct factors within human factors that exert an influence on pedestrian crossing behaviour. These factors were identified as a "risk-taker" component and a "rule-follower" component. This study suggests that the "risk-taker" component has a higher contribution to crossing behaviour, as indicated by the path coefficient in the human factors analysis.

Table 8: Contribution of the Human Factors Dimension to the Crossing Behaviour

Path	Estimate	P-value	Comment
HFC 1 (Rule-Follower) to Crossing Behaviour	0.11	0.029	Significant
HFC2 (Risk-Taker) to Crossing Behaviour	0.25	0.0001	Significant

Based on Table 8 above, the path coefficient of human factor-component 1 (HFC1) to the crossing behaviour is 0.11, and the path coefficient of human factor-component 2 (HFC2) to the crossing behaviour is 0.25. The value of the beta estimate for HFC2 to the crossing behaviour is higher than the value of the beta estimate for HFC2 to the crossing behaviour, which is 0.25 > 0.11. Therefore, it can be concluded that HFC2 contributes more to crossing behaviour.

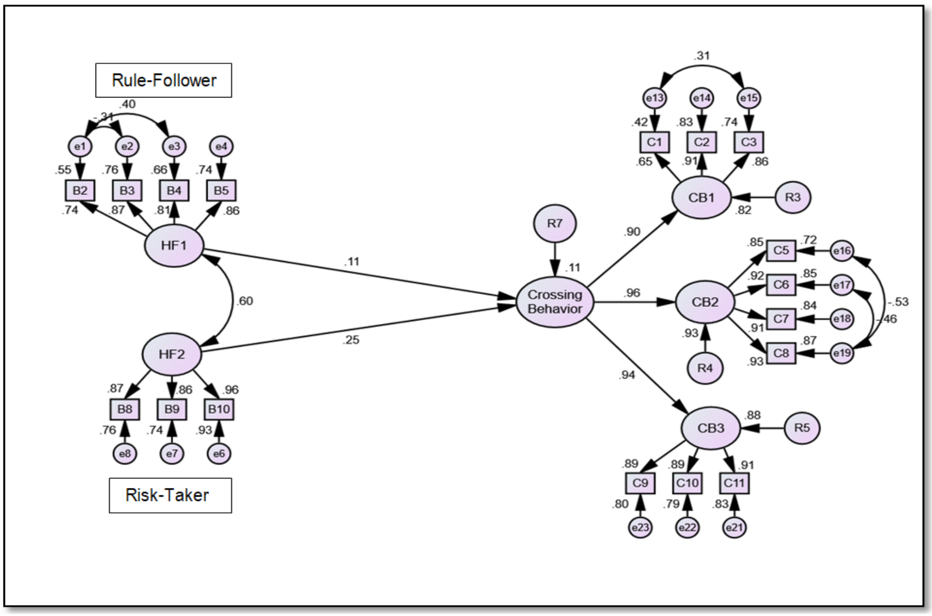


Figure 3: Contribution of the Human Factors Dimension to the Crossing Behaviour

The two group components of the human factors that influenced pedestrian crossing behaviour can be described as follows:

- "Rule-Follower" pedestrians have slightly positive attitudes, perceptions, and behaviours, as they have low scores on risk-taking (e.g., "crossing roads at designated locations reduces the risk of an accident," "crossing roads outside designated locations is illegal," "prefer routes with signalized crosswalks, "and "trying to make as few road crossings as possible").
- "Risk-Taker" pedestrians have negative attitudes, perceptions, and behaviours, as they have high scores on risk-taking behaviour (e.g., "I cross even though there are oncoming vehicles," "I cross even though the pedestrian light is red," "I cross even though obstacles obstruct visibility," and "I am absent-minded while crossing").

The introduction of two components of pedestrian crossing behaviour as explanatory variables, namely the" rule-follower" and "risk-taker" components, indicates that human factors have additional explanatory power over traffic and road factors of pedestrian behaviour. This study is therefore expected to meet the government's strategy to reduce road accidents and create more sustainable mobility environments in our cities. Sustainable mobility will not only add value to the environment but also enhance economic vitality (Rahman A. R. et al., 2015).

RECOMMENDATION

From the modelling analysis in the study area, the results showed that the "risk-taker" component contributed more to crossing behaviour. This group can be considered vulnerable pedestrians since they have high scores on risk-taking behaviours. Several actions can be suggested as an effective way of reducing the risk to this type of pedestrian:

- **The Creation of dedicated spaces for vulnerable road users**, such as upgraded sidewalks, wide pedestrian paths, and even partially or completely pedestrianised streets and squares, is recommended. Safe crosswalks are essential and should be marked and positioned appropriately. Other notable design features include excellent visibility, lighting, and the absence of visual obstacles.
- **Speed reduction** is to be made mandatory, which involves establishing speed limits appropriate to each environment and ensuring they are respected. In urban areas, for example, the speed should be limited to 50 km/h, or even 10, 20, or 30 km/h in some neighbourhoods, to encourage walking and non-motorised mobility. Adapting the road infrastructure—by narrowing the road, building refuge islands, curb extensions, raised pedestrian crossings, and speed bumps—is vital to achieving speed reduction.
- **Promotion of greater awareness** should be carried out through road safety education and training and by ensuring that the traffic laws that prioritise pedestrians are widely known and adequately enforced.

The spatial needs, mobility challenges, and cognitive capacities of pedestrians can be distinguished from each other in addition to walking pace. To help create the safest system feasible, it is essential to understand the characteristics of the variety of pedestrians who may use transit.

Table 9 below summarises some important pedestrian characteristics to consider when making pedestrian safety improvements near transit.

Table 9: Pedestrians' Spatial Needs, Mobility Issues, and Cognitive Abilities

Pedestrian Group	Characteristics & Behaviours
Children Pedestrians	• May have difficulty choosing where and when it is safe to cross the street. • May have difficulty seeing (and being seen by) drivers of all types of vehicles, including buses, because of less peripheral vision and shorter stature than adults. • May have difficulty judging the speed of approaching vehicles. • May need more time to cross a street than adults.
Elderly Pedestrians	• May have reduced motor skills that limit their ability to walk at certain speeds or turn their heads. • May need more time to cross a street than younger adults. • May have difficulty with orientation and understanding traffic signs, so they may need more information about how to access transit and get around safely. • May have difficulty judging the speed of approaching vehicles.
People with Disabilities (e.g., people using wheelchairs, crutches, canes, or people with visual or cognitive impairments)	• May be more affected by surface irregularities in the pavement and changes in slope or grade. • May need more time to cross a street than people without disabilities. • May benefit from pedestrian signal information provided in multiple formats (audible, tactile, and visual). • May have trouble seeing (and being seen) by drivers of all types of vehicles due to their seated position (for individuals using wheelchairs). • Pedestrians who are blind or who have low vision may have trouble detecting yielding vehicles or communicating visually with drivers when crossing at unsignalized crosswalks.

Pedestrian safety requires a multi-pronged approach that combines smart and inclusive road design, effective enforcement of traffic regulations, prompt post-crash response, and improved road safety education. The results suggest a need for a substantial contribution from governments, planners, and engineers to obtain an even more positive change in the safety of vulnerable road users. By convening all stakeholders in a collaborative manner to effectively and cohesively implement these proposed solutions, there is the potential to significantly impact and preserve numerous pedestrian lives.

CONCLUSION

The study of pedestrian crossing behaviour has underscored the significance of multiple elements that influence pedestrian safety at crosswalks. The use of these findings in the field of urban planning and policymaking has the potential to facilitate the implementation of customised infrastructural improvements aimed at enhancing pedestrian safety in high-density areas. Furthermore, the present study advocates for further research into other potentially influential factors, such as lighting and social group dynamics, to fully understand pedestrian behaviour at crosswalks. Overall, the study on pedestrian crossing behaviour serves as a critical reminder of the imperative to prioritise pedestrian safety and incorporate pedestrian-centric design into infrastructural development. It is essential that The study's findings on pedestrian crossing behaviour be duly considered by policymakers and urban planners in order to formulate specific infrastructural interventions that prioritise pedestrian safety in high-density areas. In conclusion, the study of pedestrian crossing behaviour sheds light on a crucial issue affecting urban areas and underscores approaches for improving pedestrian safety through infrastructural interventions that employ strategic measures.

ACKNOWLEDGEMENTS

The authors would like to thank the Ministry of Higher Education, Malaysia, for funding this research through the FRGS grant 600-IRMI/FRGS 5/3 (46/2016) and Universiti Teknologi MARA (UiTM) for supporting the research.

REFERENCES

Ab. Rahman R, Thani S.K.S.O, & Roslan R. (2019). Identifying Characters of Good Street for Greater Urban Quality of Life. Procedia - A*sian Journal of Quality of Life (AjQoL)* Vol 4 No 15.

Azmi, D.I., & Abdul Karim, H.(2018) Promoting Sustainable Urban Neighborhood towards Walkability., *Asian Journal of Environment -Behaviour Studies (ajE-Bs), 3*(8)167-175.

Bernhoft I.M., Carstensen G. (2008). Preferences and behaviour of pedestrians and cyclists by age and gender. *Transportation Research Part F* 11,pp. 83-95.

C. Fornell, and D. F. Larcker (1981) Evaluating Structural Equation Models With Unobservable Variables And Measurement Error., *Journal of Marketing Research* (18:1)39-50.

Chu X., Guttenplan M., and Baltes M. R.,(2003) "Why people cross where they do: the role of street environment," *Transportation Research Record*, no. 1878, pp. 3–10.

Diaz, E.M. (2002). Theory of planned behaviour and pedestrians' intentions to violate traffic regulations. *Transportation Research* Part F 5, 169– 175.

Elvik R., Sorensen M. W. J. and Naevestad T.-O., (2013). "Factors influencing safety in a sample of marked pedestrian crossings selected for safety inspections in the city of Oslo," *Accident Analysis and Prevention*, vol. 59, pp. 64–70.

Evans, D., Norman P. (1998). Understanding pedestrians' road crossing decisions: an application of the theory of planned behaviour. *Health Education Research 13* (4), pp. 481-489.

Evans D., Norman P. (1998). Understanding pedestrians' road crossing decisions: an application of the theory of planned behaviour. *Health Education Research 13* (4), pp. 481-489.

Fuller R., Santos J.A. (2002). Human Factors for Highway Engineers. Elsevier Science,

UK.
Nassiri H. and Sajed Y. (2009), "Using a logit model to predict pedestrian crossing behaviour based upon vehicle speed and headway on the multi-lane street," in Proceedings of the *88th Annual Meeting of the Transportation Research Board*, Washington DC, USA.
Papadimitriou E., Theofilatos A., Yannis G. (2013). Patterns of pedestrian attitudes, perceptions and behaviour in Europe. *Safety Science* 53, pp. 114-122.
Sisiopiku, V.P., Akin, D., 2003. Pedestrian behaviours at and perceptions towards various pedestrian facilities: an examination based on observation and survey data. Transportation Research Part F: Traffic *Psychology and Behaviour* 6, 249– 274.
Shriver K,(1997). "Influence of environmental design on pedestrian travel behaviour in four Austin neighbourhoods," *Transportation Research Record*, no. 1578, pp. 64–75.
Yagil, D. (2000). Beliefs, motives and situational factors related to pedestrians' self-reported behaviour at signal-controlled crossings. Transportation Research Part F: *Traffic Psychology and Behaviour 3* (1), 1–13.
Yannis G., Golias J., and Papadimitriou E., (2007). "Modeling crossing behaviour and accident risk of pedestrians," *Journal of Transportation Engineering*, vol. 133, no. 11, pp. 634–644.

Received: 24th July 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 48 – 61

RIVERINE LITTER ASSESSMENT AND RECYCLING POTENTIAL ALONG SUNGAI KELANTAN AT KAMPUNG PASIR ERA, KELANTAN, MALAYSIA

Syarifah Nur Najwa Syed Alwi[1], Latifah Abd Manaf[2], Abd Muhaimim Amiruddin[3], Sunday Yusuf Kpalo[4], Nazatul Akmal Nazibudin[5]

[1,2,3,5]*Faculty of Forestry and Environment,*
UNIVERSITI PUTRA MALAYSIA
[4]*Faculty of Environmental Science,*
NASARAWA STATE UNIVERSITY

Abstract

Nowadays in Malaysia, riverine litter has become a major environmental problem. Knowledge of solid waste generation, composition and recyclability is necessary for accurate decision making in the management strategy of municipal solid waste. This study is conducted to assess riverine litter and its recycling potential along Sungai Kelantan at Kampung Pasir Era Kelantan. The objectives are to determine the generation and composition of riverine litter and to evaluate the recycling potential of the litter. The waste samples are collected over a 14-day period at three different zones within the study area. Through quantification method, composition, proportion and the average daily total weight of the litter were determined. Findings show that the total weight of waste collected for all zones throughout the 14 days operation was found to be 70.912 kg out of which the upper-bank generated 25.9 kg. The result also shows that plastic has the highest contribution to riverine litter with 68.20%. Additionally, estimated revenue from potentially recyclable litter generated in 14 days was RM33.96. This study provides the local authority and relevant agencies with baseline information for effective management of riverine litter based on recycling potentials.
.

Keywords: riverine litter, quantification method, recycling, riverbank, solid waste, revenue estimates

[2] Senior Lecturer at Universiti Putra Malaysia. Email: latifahmanaf@upm.edu.my

INTRODUCTION

The term riverine litter refers to litter present in rivers and on river bank referred to it as solid waste being disposed or washed away into the river (Malik & Manaf 2018). Small urban rivers are thought to be major sources of riverine litter, especially macro-plastics, into the ocean (Tramoy et al., 2022). The study of riverine litter is very important as it is not only protecting the direct usage of freshwater, but also the merits of protecting riverine ecosystems (Owens et al., 2020). Even though marine debris are often discussed as the threat to the environment, riverine litter issues are very important as it can threaten the environment, human health and socio-economic activities. Estimates show that between 1.15 and 2.41 million tonnes of plastic waste currently enters the ocean every year from rivers, with over 74% of emissions occurring between May and October (Lebreton et al., 2017). There are many activities that lead to riverine litter issues such as illegal dumping and improper solid waste management by people in communities. The attitude of the people plays a vital role in influencing riverine litter. For instance, many rural areas in Malaysia are not provided with solid waste collection service due to the budget limitation by the local authorities. This makes most of the community members to throw their wastes into rivers. While most communities in urban area receive solid waste collection services, only 66% coverage is found in rural areas (Ya'acob et al., 2019).

Kampung Pasir Era is located outside the service area of Kuala Krai Municipal Council. Hence, members of the community are responsible for the disposal of the solid waste they generate. Usually, they manage and dispose their solid waste by open burning and dumping on the ground. Without a proper management, most of the solid waste gets into the river system when there is rainfall or settle on the riverbank. Storms and huge floods can transport solid waste between riverbanks and dump it far away from the water's edge, where it gathers until being washed away by another high flood (Roebroek et al., 2021). In this community, people are getting aware of the implications of riverine litter, however they tend to continue throwing their waste carelessly. For instance, despite ten years of "clean river" programmes, 700kg of trash is thrown every day into the Sungai Klang, the main river that runs through downtown Kuala Lumpur and Greater Kuala Lumpur (The Straits Times 2022). In addition, the people tend to ignore the negative effects arising from their actions and no mitigation measures are taken by all parties.

An efficient means of managing wastes is by recycling but the potential for recycling riverine litter is quite challenging. Recycling is an important part of municipal waste management and resource efficiency strategies, as well as industrial processes (Abd Rauf et al., 2021). Daily, Malaysians produce roughly 38,699 tonnes of solid garbage, or about 1.17 kilogrammes per person (Malaysia Versus Waste Features the Chemical Engineer, 2022). Recent record shows that this year's National Recycling Rate increased to 31.52 percent, up from 30.7 percent previous year, with recyclables totalling 4.3 million tonnes (The Sun Daily, 2022). However, the recycling rate is still low as the National Recycling Rate is targeted at 40% by 2025. Therefore, by assessing the potential recyclable material from riverine litter, recycling rate can be increased thereby reducing the waste disposal at the landfills.

According to Malik and Manaf (2018), quantifying the types and abundance of riverine litter not only provides baseline data for the waste reduction programmes, but it can also describe the potential of recyclable materials from the waste stream. There is not enough data to provide solutions to riverine litter as there are only a few studies on riverine litter especially on plastic materials (Sadri & Thompson 2014). It is vital to have a sufficient data on riverine litter materials so that it can be assessed for recycling purposes after the litter collection from the river is done.

Thus, this study is conducted to assess riverine litter and its recycling potential along Sungai Kelantan at Kampung Pasir Era Kelantan. The objectives are to determine the generation and composition of riverine litter and to evaluate the recycling potential of the litter. Riverine litter quantification and composition are very important in understanding the attendant problems associated with it and recommending solutions to solve such issues. This study anticipates that quantifying the types and abundance of riverine litter will help organisations involved with waste management to provide proper management solutions and baseline data for waste reduction programmes.

MATERIAL AND METHODOLOGY

Study Area

Sungai Kelantan is a major river in Kelantan (Figure 1). Its drains a catchment area of about 11,900 km^2 in north-east Malaysia including a part of Kuala Koh National Park and flows northward to South China Sea. For this research, Sungai Kelantan along Kampung Pasir Era in Kuala Krai district was selected as the study area. Kampung Pasir Era is situated in Kuala Krai, Kelantan. Its geographical coordinates are 5° 32' 2" North, 102° 11' 58" East and with about 1.3 km length. It consists of 700 people with various background. Kampung Pasir Era was selected as the study area being a non-serviced residential area and transportation centre that connect the river to the other sides of Sungai Kelantan.

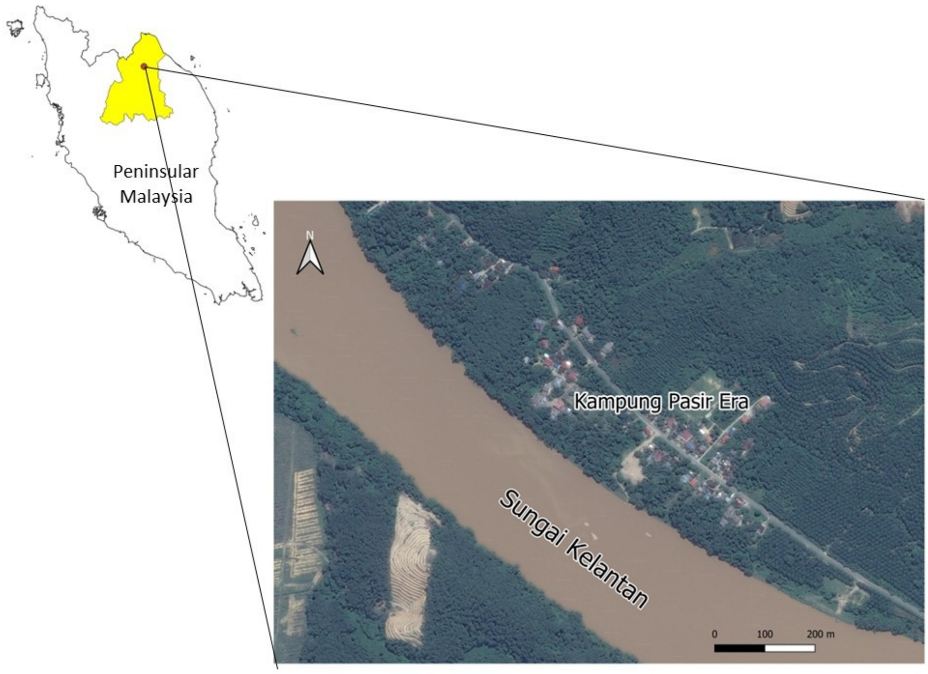


Figure 1: Study area along Kelantan River in Kampung Pasir Era.
Source: Google Map, 2023

Sampling Procedure

For litter sampling, only the river bank was considered and no litter was sampled from the river bed. The study area was divided into three zones namely the river shore, mid bank and upper bank. For each zone, three circles with 2-meter radius were sampled. Being an uneven riverside ground, with rocks and vegetation, it is often difficult to mark the sampling area with standard quadrats. Therefore, sample in circle was chosen, which was defined by fixing a line with the length of the radius in the center of each circle, and marking the outer edge of the circle along the tightened rope. Everything visible within the given area that is attributable to human activity was collected. 14 days of sampling for riverine litter collection was conducted within the months of August to October as per Malik and Manaf (2018). These months are usually rainy seasons in Malaysia.

Secondary Data for Maximum Wind Speed and Total Rainfall

A secondary data of maximum wind speed and total rainfall for 14 days of operation day was obtained from World Weather Online. The data for both parameters is shown in Table 1.

Table 1: Maximum Wind Speed and Total Rainfall for 14 Days

Day	Rainfall (mm)	Wind Speed (kmh)
1	1.6	6
2	0.9	5
3	0	3
5	0.1	3
5	1.4	4
6	0	4
7	0.1	4
8	0.1	4
9	0.6	5
10	1.1	4
11	0.8	4
12	0.9	5
13	4	4
14	1.9	8

Source: Kuala Krai, Kelantan, MY Historical Weather Almanac

Quantification Method

Quantification method is used for determining the sorts of things dumped in a waste stream and the proportions in which they are disposed (Alias et al., 2019). This study employed quantification at the waste collection point. Sorting was carried out on the same day after the waste was collected. After every session of waste sampling, the waste was analysed by sorting and weighing according to its type. The sample of waste was segregated manually into eight different components and placed in containers. In this study, the riverine litter composition was classified into eight different types of waste (plastics; metal; cardboard/paper/tetrapak (CPT); glass; bulky waste; napkins; rubber; textiles; and others). The weight of each sorted composition was measured with a weighing balance and recorded. At the end of every sorting, the individual weights were summed together to give the average daily total weight of riverine litter collected. Finally, the percentage composition of each of the components was then calculated.

Revenue estimation for recyclable litter

Recycling is an important part of municipal waste management and resource efficiency strategies, as well as industrial processes (Hotta et al., 2015). Differentiating the solid wastes among recyclable and non-recyclable categories was done after obtaining the weight percentage of each individual component. Among the waste materials found, only plastics, glasses, CPT and aluminium were considered for recycling, hence, how much they cost was sought for. Table 2 shows the price list for recyclable materials based on current market price from

Alam Flora. The estimated value for recyclable material is calculated by converting the total weight of potential recyclable material into Malaysian Ringgit (RM). The calculation is done using the following equation adapted from revenue estimation described in Samah et al., (2015).

$$E_r = T_w \, xW_p \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots... \qquad \text{Eq 1}$$

Where:
ER = Estimated revenue
Tw = Total weight
Wp = Price of waste material

Table 2: Price list for recyclable materials

Litter type	**Price per kg (RM)**
Plastic	0.40
Glass	0.10
CPT	0.45
Aluminum	2.00

Source: (Oon,2022)

Data Analysis

The study utilised both descriptive and inferential statistics to analyse the data obtained. Descriptive analysis was used to describe the characteristics of the collected samples along the Sungai Kelantan in Kampung Pasir Era. It is very useful to collect information on the total weight of riverine litter during the sample collection and the weight of different types of waste composition; the means, standard deviation (SD) and range of minimum and maximum value for each variable; and others relevant information. For the inferential statistics, one way analysis of variance (ANOVA) was conducted to compare the mean between variables and to identify the significant difference between variables (i.e., between the litter collected at the river shore, middle-bank and upper-bank)

ANALYSIS AND DISCUSSION

Composition of riverine litter

Figure 2 shows the percentage composition of waste collected at the riverbank along Sungai Kelantan at Kampung Pasir Era. Plastic has the highest contribution to the riverine litter with 68.20% while textiles had the least contribution with only 0.92%. The mean and SD of the composition of the collected waste is also shown in Table 3. Most of the plastic waste come from various sources such as food packaging, water bottle, plastic bag and polystyrene. Since Kampung Pasir

Era is within the non-service area of Kuala Krai District Council (KKDC), there was no bin provided at the area. Hence, the people tend to litter instead of throwing it at a designated area. Similar composition or riverine litter was reported in Malik and Manaf (2018) and was attributed to illegal dumping and littering activities and subsequently transported into the river by water surface runoff.

Additionally, Schirinzi et al 2020 studied two rivers the Llobregat and Besòs located in Catalonia, to analyse the riverine anthropogenic litter load. Results showed similar waste composition in both rivers, mostly represented by plastic material: 67.7% and 50.5% respectively. Plastic pollution in aquatic environments is one of the most fatal environmental issues in the world (Battulga et al., 2019).

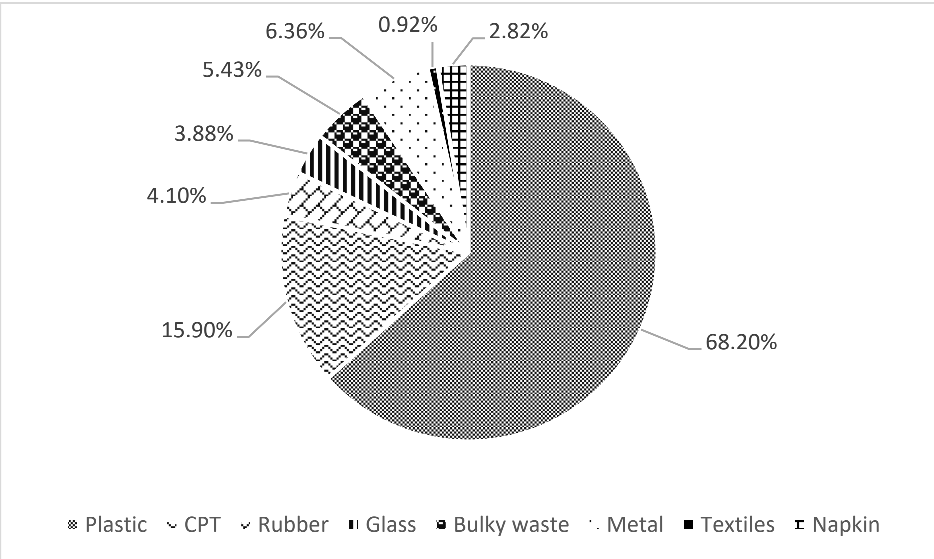


Figure 2: The proportion of riverine litter (% by weight)

Table 3: Riverine litter composition (Mean ± standard deviation)

Litter type	N	Minimum	Maximum	Mean	Standard deviation
Plastic	14	2.26	4.93	3.4564	0.67041
CPT	14	0.52	1.13	0.8100	0.18322
Rubber	14	0.00	0.59	0.2086	0.20501
Glass	14	0.00	0.880	0.1964	0.30631
Metal	14	0.00	0.86	0.3221	0.31445
Napkin	14	0.00	1.00	0.1429	0.36314
Bulky waste	14	0.00	2.00	0.2500	0.64301
Textile	14	0.00	0.65	0.0464	0.17372

Daily Riverine Litter Generation by zones

At the river shore, day 14 recorded the highest total weight collected at the river-shore (2.69 kg) as indicated in Figure 3. This is due to the maximum wind speed and total rainfall during Day 14 which is higher compared to other days as earlier shown in Table 1. The lowest waste generated at the river shore was during Day 2 as the total rainfall and wind speed on that day was moderate. Wind plays a vital role as a transportation agent to transport litter to the riverbanks compared to precipitation and water level. High wind speed will transport the litter from upper- bank to middle-bank and river-shore. Runoff from precipitation, has been proposed as a major factor in litter transport (Roebroek et al., 2021).

At the middle-bank, the pattern of riverine litter generation was similar to that of the river shore on some operation days and differed on others as observed in Figure 2. Day 14 shows the highest amount of riverine litter at the middle-bank while Day 12 recorded the lowest amount of riverine litter. The variations in wind speed recorded on both days may have contributed to the trend. Eventually the litter from the upper-bank will be transported to the middle-bank.

For the upper-bank, the riverine litter generated peaked on Day 9 while Day 1 recorded the lowest amount of riverine litter. Low wind speed and minimum total rainfall influence the movement of the litter at the riverbank as the litter tend to stay at the upper-bank. Also, human activities could have led to the higher riverine litter generation based on the high the number of vehicles parked at the upper-bank. Studies have reported that the major source of riverine litter is recreational activity near the riverbank (Gasperi et al., 2014) and high urban activities in that area (Carson et al., 2013).

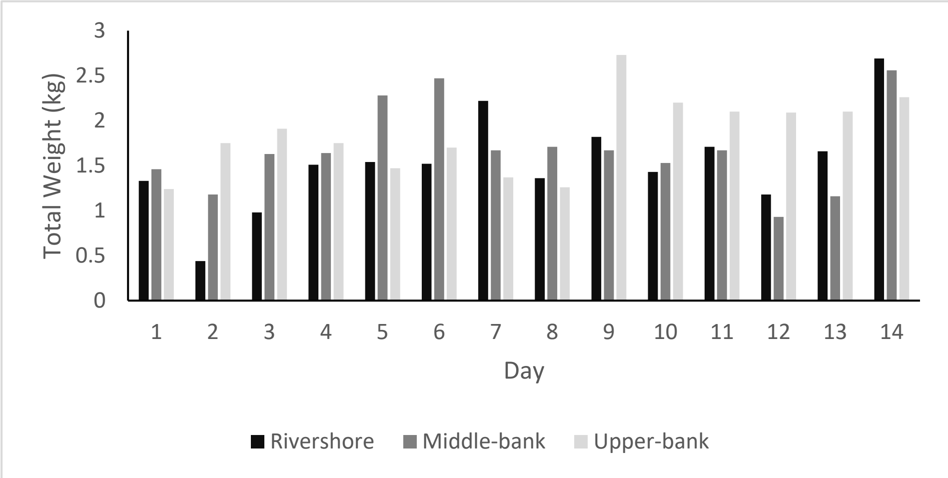


Figure 3: Daily riverine litter collected during 14 days by zones.

Total weight of riverine litter for each zone of riverbank

The result in Figure 4 shows the total weight of riverine litter for each zone of riverbank. As indicated, the upper-bank generated 25.9 kg of litter which is the highest total weight of riverine litter collected during 14 days operation. On the other hand, the operation at the river shore contributes the lowest amount of riverine litter which is 21.4 kg. Also, Table 4 shows the weighted average amount and SD for total weight of riverine litter at the upper-bank was 1.5821 ± 0.4286 (kg/operation day) while it was 1.5279 ± 0.5297 (kg/operation day) at the river shore. One-Way ANOVA test was conducted to identify whether there is significant difference between total weight of riverine litter at the river shore, middle bank and upper bank. Based on the results in Table 5, there is no significant difference between each zone as $p = 0.214$ is larger than 0.05. Even though there is high waste accumulated at the upper bank, the presence of wind speed and rainfall will redistribute the waste to the other part of riverbank.

The upper-bank contributed the highest amount of riverine litter due to its location near the main road. Besides, as Kampung Pasir Era is a transportation centre for the people to go to the other side of the river, several parking lots are provided for the vehicles. Most of the people park their vehicle at the upper-bank of the river. The frequency of illegal trash along riversides is thought to be influenced by the land use and accessibility of the area, particularly to vehicles (Samah et al., 2015). The river shore has the lowest amount of riverine litter because it is located near the water. According to Rech et al (2015), river shore is located at the edge of water with maximum three meter away from water. It is permanently in contact with the water. Therefore, the litter at the river shore will be carried away constantly into the river compared to upper bank which is located further away from the water body.

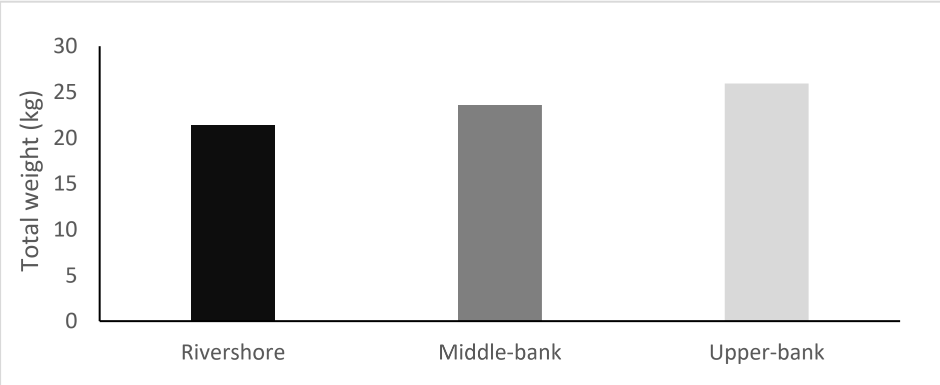


Figure 4: Total weight (kg) of riverine litter collected for each zone

Table 4: Descriptive analysis for total weight of riverine litter for each zone

Zones	**N**	**Minimum**	**Maximum**	**Mean**	**Standard deviation**
River shore	14	0.44	2.69	1.5279	0.52970
Middle bank	14	0.93	2.56	1.6829	0.47373
Upper bank	14	1.24	2.73	1.5821	0.42865

Table 5: ANOVA for waste generation at different zones.

Source of variation	Sum of squares	df	Mean squares	p-value
Between groups	0.737	2	0.368	0.214*
Within groups	8.954	39	0.230	
Total	9.690	41		

**Not significant*

Total Riverine Litter Collected per operation day at Kampung Pasir Era

The result of the total weight of waste collected for all zones per operation day at the study area from August until October 2021 is shown in Figure 5. Overall, the combined weight throughout the 14 days operation was 70.912 kg. Specifically, the result shows that Day 14 contributed the highest amount of riverine litter collected during operation days at 7.51 kg/operation day due to the high heterogeneous nature of the waste. However, the operation during Day 2 contributed the lowest amount of riverine litter at 3.37 kg/operation day due to the small amount of plastic waste collected on that day with 2.26 kg/day compared to other days. In addition, there was no glass and metal waste collected on Day 2, leading to small amount of riverine litter. In this situation, even though there are a variety of possible causes of litter along rivers, such as boats, sewage, and rainwater runoff, illegal dumping appears to be a substantial source of litter along the rivers surveyed, as observed in Malik et al (2018). Alternatively, it may be caused by the poor solid waste management and the lack of awareness among the community.

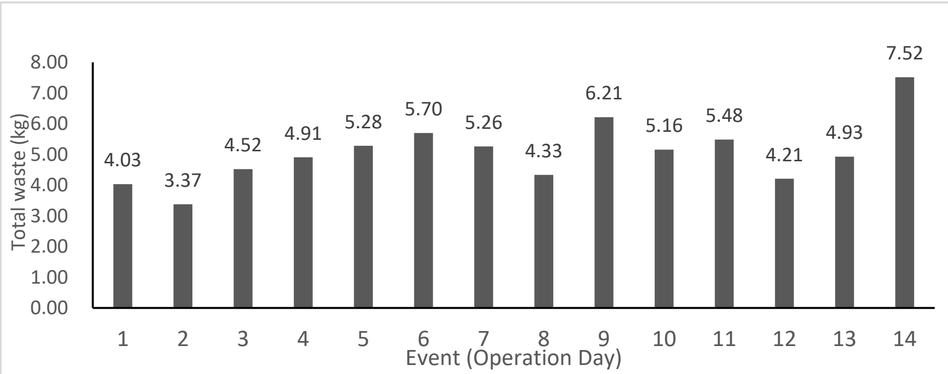


Figure 5: Total weight(kg) of riverine litter during 14 days of operation day.

Many people do not know about the implication of littering, especially at the riverside. The accumulation of floating litter, particularly plastic garbage, has been linked to a lack of recycling, waste management, and littering behavior on a global scale.

Potential recyclables material from riverine litter composition

The most potentially recyclable materials from riverine litter are plastic, cardboard, paper, tetrapek (CPT); glass, and metal. As found in this study, the composition of plastic is 68.20% (3.456 ± 0.6704), CPT; 15.9% (0.81 ± 0.1831), metal; 6.36% (0.3221 ± 0.31445) and glass; 3.88% (0.1964 ± 0.3063). Based on the observation during data collection, most of CPT were derived from the food packaging like pizza boxes and drink boxes meanwhile metals were mostly derived from aluminium cans. Aluminium can is one of the most sought-after materials with high potential to be recycled due to its high price. Table 6 shows the estimates of potential revenue that can be generated from the sale of riverine litter collected at the riverbank in Kampung Pasir Era for the purposes of recycling. The estimated revenue was calculated based on the current prices of litter obtained from Alam Flora Sdn Bhd. Going by the results, revenue generated for litter in 14 days was RM33.96. It implies that the average revenue per day will be RM2.43 and approximately RM75.33 in a month if the same quantity of litter is generated.

Therefore, based on the estimated revenue recorded, recycling activities should be encouraged by the local authority. The villagers can reduce their waste and earn money from these activities. Waste minimisation should be promoted as the landfills cannot support more waste in the future as the waste generation in Malaysia is increasing rapidly by the year.

Table 6: Estimated revenue from litter collected at the riverbank

Litter type	Quantity (kg)	Unit price/kg (RM)	Value (RM)
Plastic	48.93	0.40	19.57
Glass	2.75	0.10	0.27
CPT	11.34	0.45	5.10
Aluminum can	4.51	2.00	9.02
Total			33.96

CONCLUSION

In conclusion, there is high abundance of riverine litter along Sungai Kelantan at Kampung Pasir Era with the total weight collected for 14 days is 70.912 kg (5.0651±1.1097 kg/operation day). Event 14 contributes the highest amount of riverine litter collection which is 7.51 kg/operation day. Upper-bank recorded the highest waste collected compared to other zones with the total weight 25.9 kg 1.8521±0.4286 (kg/operation day). For the waste composition, plastic dominantly contribute to the riverine litter with 68.2%. The estimated revenue for high potential recyclable material is RM 33.96. Based on this study, the data on waste generation and composition can be used for the knowledge contribution regarding the solid waste management to solve the riverine litter issue in Malaysia. Other than that, the government should make a new policy about the service collection in the rural area as there are improper solid waste management in that particular area. Besides, awareness campaign for the villagers should be held so that they are more responsible of their actions and improve their attitude.

ACKNOWLDGEMENTS

This study is supported by Fundamental Research Grant Scheme (FRGS/1/2019/WAB05/UPM/02/9). The authors would like to thank the head of Kampung Pasir Era for providing background information about the community and access to it. Also, the staff of the Sultan Abdul Samad library in UPM for the access and use of its electronic and print resources are hereby acknowledged.

REFERENCES

Abd Hamid, K.B., Ishak, M.Y., & Abu Samah, M.A. (2015) Analysis of municipal solid waste generation and composition at administrative building café in Universiti Putra Malaysia: A case study. *Polish Journal of Environmental Studies*, 24(5). https://doi.org/10.15244/pjoes/39106

Abd Rauf, N.R.A.A., Yakob, H., Abdullah, Y.A., Leh, L.O.H., Marzukhi, M.A., & Othman, R. N. R. (2021). Exploring the Theory Planned Behaviour to Derive the Factors of Human Behaviour for Domestic Waste Recycling. Planning Malaysia, 19. https://doi.org/10.21837/pm.v19i16.967

Alias, F. S., Manaf, L. A., Ariffin, M., & Abdullah, S. H. (2019). Enhancing the potential of recyclables waste collection through waste bank programme: Experience from hei in Malaysia. *Planning Malaysia, 17*. https://doi.org/10.21837/pm.v17i10.637

Battulga, B., Kawahigashi, M., & Oyuntsetseg, B. (2019) Distribution and composition of plastic debris along the river shore in the Selenga River basin in Mongolia. *Environmental Science and Pollution Research*, 26,14059-14072.https://doi.org/10.1007/s11356-019-04632-1

Gasperi, J., Dris, R., Bonin, T., Rocher, V., & Tassin, B. (2014). Assessment of floating plastic debris in surface water along the Seine River. *EnvironmentalPollution*,195,163–166. https://doi.org/10.1016/j.envpol.2014.09.001

Hotta, Y., Visvanathan, C., & Kojima, M. (2015). Recycling rate and target setting: challenges for standardized measurement. *Journal of Material Cycles Waste Management*,18, 14–21. https://doi.org/10.1007/s10163-015-0361-3

Kuala Krai, Kelantan, MY Historical Weather Almanac. Available from: https://www.worldweatheronline.com/kuala-krai-weather-history/kelantan/my.aspx (Accessed on 2022 April 14)

Lebreton, L. C., Van Der Zwet, J., Damsteeg, J.W., Slat, B., Andrady, A., & Reisser, J. (2017). River plastic emissions to the world's oceans.
Malaysia Versus Waste Features the Chemical Engineer. Available from: https://www.thechemicalengineer.com/features/malaysia-versus-waste/ (Accessed on 2022 Mar 25).

Malik, N.K. A., & Manaf, L.A. (2018). Potential recyclable materials derived from riverine litter at log boom Sungai Batu in Kuala Lumpur. *Journal of Material Cycles and Waste Management,20,* 1063-1072. https://doi.org/10.1007/s10163-017-0670-9

Nature Communications, 8 (1),15611. https://doi.org/10.1038/ncomms15611

Oon AJ. Recycle These 20 Items with Alam Flora and Earn Money. Available from: https://says.com/my/lifestyle/alam-flora-buys-cooking-oil-plastic-waste-and-old-newspapers (Accessed on 2022 April 14)

Owens, K. A., & Kamil, P. I. (2020) Adapting Coastal Collection Methods for River Assessment to Increase Data on Global Plastic Pollution: Examples from India and Indonesia. *Frontiers in Environmental Science,* 7,208. https://doi.org/10.3389/fenvs.2019.00208

Rech, S., Macaya-Caquilpán, V., Pantoja, J. F., Rivadeneira, M. M., Campodónico, C. K., & Thiel, M. (2015). Sampling of riverine litter with citizen scientists —

findings and recommendations. *Environmental Monitoring and Assessment*, 187, 1-18. https://doi.org/10.1007/s10661-015-4473-y

Roebroek, C. T., Hut, R., Vriend, P., De Winter, W., Boonstra, M., & Van Emmerik, T. H. (2021). Disentangling Variability in Riverbank Macro-litter Observations. *Environmental Science & Technology*, *55*(8), 4932–4942. https://doi.org/10.1021/acs.est.0c08094

Sadri, S. S., & Thompson, R. C. (2014). On the quantity and composition of floating plastic debris entering and leaving the Tamar Estuary, Southwest England. *Marine Pollution Bulletin*, 81(1), 55–60. https://doi.org/10.1016/j.marpolbul.2014.02.020

Samah, M.A.A., Abd Hamid, K.B., Ishak, M.Y. (2015). Analysis of Municipal Solid Waste Generation and Composition at Administrative Building Cafe in Universiti Putra Malaysia: A case Study. *Polish Journal of Environmental Studies, 24* (5), 1969-1982 https://doi.org/10.15244/pjoes/39106j

Schirinzi, G.F., Köck-Schulmeyer, M., Cabrera M., González-Fernández, D., Hanke, G., Farré, M., & Barcelo, D. (2020). Riverine anthropogenic litter load to the Mediterranean Sea near the metropolitan area of Barcelona, Spain. *Science of the Total Environment*, 714, 136807. https://doi.org/10.1016/j.scitotenv.2020.136807

The Straits Times. Loads of rubbish clogging up Malaysian rivers. Available from: https://www.straitstimes.com/asia/se-asia/loads-of-rubbish-polluting-choking-malaysian-rivers (Accessed 2022 May 23)

The Sun Daily. National Recycling Rate shows slight improvement at 31.52%. The Sun Daily. Available from: https://www.thesundaily.my/local/2021-national-recycling-rate- shows-slight-improvement-at-3152-DX8671115 (Accessed on 2022 Mar 25).

Thompson, R. C., Moore, C. J., Vom Saal, F. S., & Swan, S. H. (2009). Plastics, the environment and human health: current consensus and future trends. *Philosophical Transactions of the Royal Society B*: *Biological Sciences*, 364(1526), 2153–2166. https://doi.org/10.1098/rstb.2009.0053

Tramoy, R., Blin, E., Poitou, I., Noûs, C., Tassin, B., & Gasperi, J (2022). Riverine litter in a small urban river in Marseille, France: Plastic load and management challenges. *Waste Management,* 140, 154-163. https://doi.org/10.1016/j.wasman.2022.01.015

Yaacob, N.N.F., Abd Manaf, L., & Ash'aari, Z.H. (2019). Quantifying the organic waste generated from the fresh market in Kundasang Town, Sabah. *Planning Malaysia, 17*. https://doi.org/10.21837/pm.v17i10.633

Received: 26th June 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 62 – 77

COMBINATIVE FRAMEWORK FOR VALUE ENGINEERING AND BUILDING INFORMATION MODELLING IMPLEMENTATION AT LOD300 STAGE

Ahmad Aqil Zaidi[1], Saipol Bari Abd-Karim[2], Syed Muzaffar Syed Mohamad[3], Hsiao Yun[4]

[1,2,3,4] Centre for Building, Construction and Tropical Architecture (BuCTA), Faculty of Built Environment, UNIVERSITI MALAYA, MALAYSIA

Abstract

Value Engineering (VE) involves a multidisciplinary team approach in a highly systematic workshop aimed at achieving Value for Money (VfM) focused on improving the function of a project, product, or service, not merely reducing costs. In the construction industry, VE is applied during the design or pre-construction phases of public, private, or Building Information Modelling (BIM)-based projects where benefits can be maximised. VE can be implemented more effectively with BIM, especially in providing accurate and adequate information. It is important to understand how these two concepts are related and how they benefit projects. Nevertheless, there is a dearth of research that combines VE practice with BIM to evaluate viable alternatives or improve design. This paper investigated the need for VE in the LOD300 phase for construction projects in Malaysia. In this work, a quantitative methodology was used to incorporate findings from the literature into a questionnaire survey that was purposefully distributed to industry practitioners with knowledge of VE, BIM, or both. A sample of 186 was drawn from a total population of 353 professionals: Members of the Institute of Value Management Malaysia (IVMM), Public Works Department of Malaysia (PWD) VM and BIM, and myBIM Centre Malaysia. 32% of responses were received, and the data collected were analysed using the Statistical Package for Social Sciences (SPSS). Based on the results, a framework was developed to include VE at the LOD300 phase in BIM. This paper provides empirical evidence of the benefits of this approach and offers construction practitioners with an overview of how VE can be systematically applied to BIM.

Keywords: Value Engineering; Building Information Modelling; detailed design stage; construction industry

[2] Corresponding Email: saipolbari@um.edu.my

INTRODUCTION

Value Engineering (VE) is a creative, organised effort that assesses the requirements of a project with the goal of accomplishing the required functions at the lowest total cost (capital, staffing, energy, and maintenance) over the life of the project (Thomas, 2019). The success of the VE exercise is mainly influenced by the relationship of the multidisciplinary VE team, which is primarily determined by effective communication and strategic action of the team members. Male et al. (2007) found that the parts of the VE process, which include the study process, the commitment of team members involved in the project, the administration of the VE process, the commitment of executives, and efficient facilitation, influence the success of the VE exercise. Meanwhile, Building Information Modelling (BIM) is a recent innovation that is being considered to address issues such as low productivity in the architecture, engineering, and construction (AEC) industry (Abbasnejad et al., 2021). BIM offers significant advantages to the construction industry across the project's life cycle. Saraireh et al. (2020) pointed out that BIM technology generates a digitally created detailed virtual view of a building. This model can be used extensively in the planning, design, construction, and operation stages of facilities. Equally important, BIM has demonstrated its ability to boost efficiency and productivity throughout the design stage (Bentley, 2017; Haron et al., 2015; Migilinskas et al., 2013). VE implementation can be planned as part of the BIM preparation process to ensure smooth project execution. According to the previous research by Li et al. (2021), it is possible that approaches to integrate VE into BIM have the essential function of visualisation and clear information, and subsequently enhance both performances.

Background

SAVE International (2015) indicates that VE methodology is a systematic and structured method for enhancing projects, products, processes, services, and organisations. It helps to achieve the best possible balance between function, performance, quality, safety, and cost. The primary goal of the VE in construction is to eliminate superfluous expenses while enhancing the level of performance and quality in such a way that the owner's demands are met or satisfied. Although the VE method is gaining more and more attention from stakeholders (Baarimah, et al, 2021), the conventional VE method has several shortcomings or restrictions, such as an overemphasise on cost and not promoting nor improving creativity (Wao 2015). The application of VE alone is insufficient to prevent the desired goals from being realised (Li et al., 2021). Theoretically, there are a variety of software solutions available in the AEC industry to facilitate interdisciplinary collaboration work (Faraj et al., 2000; Rosenman et al., 2007), especially BIM, which has recently emerged and is being used in many countries, including

Malaysia (Latiffi et al., 2013). In a randomised controlled study of the behaviour of BIM, Li et al. (2014) reported that modern BIM tools have enabled a response system that tracks the impact of design changes associated with costs. Li et al. (2014) added that the visualisation of construction activity analysis aids cost planning operators in identifying conflicts and communicating design alternatives that may be more cost-effective and time-saving.

VE and BIM share the same objectives in terms of effectiveness and cost reduction. Both include a life-cycle view of completed and operational assets. One way that BIM can help with VE is by allowing for faster analysis of alternative design options (RICS, 2017). As a result, it is incredibly beneficial for the integration of VE in BIM in the AEC industry to optimise and maximise its benefits. Although many researchers, such as Baarimah et al. (2021), Dcrnirdogen et al. (2021), and Wei and Chen (2020), had taken the initiative to understand and research the integration of VE in BIM, Li et al. (2021) discussed that there has been no study conducted on how VE is being applied in BIM to enhance the design or choose a suitable alternative. Despite several studies that have been carried out to state the usefulness and effectiveness of BIM and VE separately, the research on combining and integrating VE in BIM is lacking. In order to fill this gap, this paper investigated the potential integration of VE in BIM during the detailed design stage for the construction project in Malaysia.

LITERATURE REVIEW

Value Engineering

As part of the value management (VM) process for projects, VE interventions are implemented in the design development stage and are considered a disciplined method for delivering required functionality and quality while preventing unnecessary costs (Kelly et al., 2014). In the design stage of project implementation, VE is often used to align or re-align technical solutions to meet business requirements and scope (JKR Malaysia, 2013). According to the Economic Planning Unit (EPU) (2011), VE must be applied at all levels of design development to ensure that the project achieves the specified functions and objectives. This method must be performed to find alternatives and the optimal method to implement a project to optimise value for money and increase the effectiveness of the project.

VE in Malaysia

In Malaysia, VE was introduced in 1986 (Che Mat, 2010; Jaapar, 2008; Jaapar & Torrance, 2007). It is evident that its application is increasing in Malaysia. Therefore, in order to aggressively promote the use of VE in the industry, it is crucial to first analyse the current stage of its application before developing a system of VE concepts to suit the existing local environment. The Economic

Planning Unit (EPU) of the Prime Minister's Department established a dedicated VM division to manage VM for government projects and programmes. To enhance the value of future public projects and programmes, the EPU released the "Value Management Guidelines Circular 3/2009," which made VE/VM mandatory for public projects worth RM50 million and above (Jaapar et al., 2012). Subsequently, the EPU published its first implementation guideline for VM in government projects, which became the main reference for VM implementation in 2011. In addition, the Malaysian Public Works Department (PWD) published its own VE guidelines in 2013, which are consistent with the EPU implementation guide. Both EPU and PWD are working closely to strengthen the implementation of the value methodology for the government.

Prior to mandatory implementation for public projects and programmes, VE/VM was implemented in various private projects. According to Abd-Karim (2016), Malaysia Airport Holdings Berhad (MAHB) published the first guideline for VM implementation in 2008. This guideline is the result of successful VM studies conducted for works, supplies, systems, and facilities valued at over RM300,000. Meanwhile, the establishment of the Institute of Value Management Malaysia (IVMM) in 2000 shaped the landscape and served as the foundation for the institutionalisation of value methodology in the country. IVMM published the National VM Guide in 2018 and the VM Competency Standard in 2021, which have strengthened the VE/VM implementation structure in Malaysia.

VE implementation

The VE process is conducted through a structured set of steps or phases called ‘job plans’ that are followed systematically during the workshop. The VE job plan was initially developed by Miles in 1961 and continued to be investigated and developed as part of enhancing the implementation of VE (Abd-Karim et al., 2011). According to JKR Malaysia (2013), a job plan comprises three stages: Pre-Lab, Lab, and Post-Lab. The Pre-Lab Stage of any VE study is the planning phase in which the study context and objectives are set, project information is acquired and analysed, and the lab agenda and logistics are planned. At this stage, the project's readiness to undergo VE will be assessed, information will be collected and synthesised, and VE lab activities will be planned. The members will investigate value misalignments and devise methodologies, tools, and approaches for attaining VE study objectives. During the Lab Stage, the lab members will delve more into value discrepancies and possibilities for achieving or improving existing situations. The Lab members will jointly produce, assess, and develop options during the interaction before recommending the best solutions. The Lab stage typically lasts 3-5 days, depending on the design complexity and scope of the VE study. To enable efficient and robust decision-making, the following Lab phases are carried out in this order:

1) Information – To develop an understanding of the project and its details and verify the project's details.
2) Function – To understand the project's functions and to identify mismatches and potential value improvements.
3) Creative – To generate innovative and creative ideas as alternative ways to perform functions and enhance the project's value.
4) Evaluation – To identify and shortlist potential value-improvement ideas from the generated ideas.
5) Development – To develop ideas as workable options into the best or preferred solutions by further analysing their viability.
6) Presentation – To present and gain approval from stakeholders to proceed with the VE implementations.

Building Information Modelling (BIM)
Construction projects are becoming increasingly complex and challenging to govern. Information and communication technology (ICT) has been developing at a rapid pace in response to the rising complexity of projects (Bryde et al., 2013). One of the most promising recent innovations in the AEC industry is Building Information Modelling (BIM). BIM technology creates a digitalised exact virtual representation of a building. This model, referred to as a building information model, can be applied to facility planning, design, construction, and operation. It has evolved into a necessary technique, which includes the digitalisation of the built environment supply chain (Saraireh et al., 2020). According to what has been defined by Succar (2009), BIM is a digitised format for integrating building design and project data over the course of the life cycle of the building. It is possible to conclude that BIM is a technique for creating digital (3D) information models using the appropriate tools in order to facilitate communication and engagement among stakeholders.

BIM in Malaysia
Since 2009, the private sector has been primarily responsible for the advancement of BIM in Malaysia. In 2007, the Director of Malaysia's PWD proposed the idea of using BIM in Malaysia. As a result, the first government project to adopt the BIM methodology was unveiled in 2010 (Haron et al., 2017). The PWD has embraced BIM since then, with the target of implementing BIM on 50% of projects worth RM10 million and above, with an increase of 10% in the following year under the PWD Strategic Plan 2021-2025. Through BIM, stakeholders can

utilise the developed data not only in the planning and design phase, but also in the implementation phase during construction.

BIM adoption necessitates the creation of dependable mechanisms for the transfer of information between different software tools. It also requires enabling efficient and direct coordination and monitoring procedures between project participants and team members. An acceptable level of interoperability and standardisation of work practices must be achieved for project participants and team members. The collective expertise of project participants enables us to define the decision-making process prior to the use of BIM in individual projects. It also allows us to make recommendations for the planning process in a small business environment with different software and work methods (Migilinskas et al., 2013).

Generally, there are conflicting views on the benefits of BIM, leading to widespread misunderstanding of the projected outcomes. Farouk et al. (2023) conducted a study on trust challenges and strategies in BIM-based projects in Malaysia and found that organisations must create more trust and faith in the transition to BIM. The number and range of definitions demonstrate the current ambiguity in describing and quantifying BIM, as well as in analysing its potential benefits (Haron et al., 2017). Any definition of BIM should not be one-sided but should include the essential features assigned to it. There is a risk in providing a restrictive definition of BIM as it makes establishing a baseline for comparison more difficult (Izadi Moud & Abbasnejad, 2012). A restricted definition also makes benchmarking difficult, if not impossible, for improving BIM utilisation.

BIM Level of Development (LOD)

BIM is a technical creation that is used in the geometric modelling of a facility's performance and the administration of construction projects (Farouk et al., 2023) BIM replaces 2-dimensional (2D) drawings with a 3-dimensional (3D) model as part of an architectural design. The 3D model for the construction project must be intertwined with contextually data-rich building subcomponents. Lévy (2011) stated that all data concerning contextual data-rich building elements were derived primarily from the level of development specification. The American Institute of Architects (AIA) established the Levels of Details (LoD) in 2008, when it initially introduced five 'levels of development' for defining the amount of detail about the BIM model. But later, to help the building trades adopt and implement them in a better way, the Levels of Development (LOD) were published in 2013 (United BIM, 2023). The LOD concept is established in BIM to allow construction stakeholders in the AEC industry to specify and express with a high level of content clarity while also ensuring the reliability of the 3D models at various stages.

According to Latiffi et al. (2015), there are five (5) levels of LOD, where each level represents a distinct set of content criteria, approved model use, and model purpose: LOD100 (Concept Design), LOD200 (Schematic Design), LOD300 (Detailed Design), LOD400 (Fabrication & Assembly), and LOD500 (As-built). LOD300 is similar to construction documentation, where the model will contain accurate quantity, size, location, orientation, and detailing, fabrication, assembly, and installation information. Information contained in LOD300 models can be used during the construction phase of the project (United BIM, 2023). Moreover, there is also a specification for LOD350 that develops coordination between any disciplines, such as clash detection. LOD is used to address a variety of issues that arise during the design stage. BIM users can specify the use of the building models, and stakeholders can understand the usability and limitations of the models they receive (Latiffi et al., 2015).

Design Changes in Construction Project

In many construction projects, frequent design changes may negatively affect project performance, cost overruns, delays, and function failures. Mohamad et al. (2012) classified the key sources of design changes as clients, consultants, and contractors, who are the primary parties in building construction projects. However, despite the negative impact of design changes, little attention is given to proactively managing these effects, such as through VE and BIM implementation (Kelly & Male, 2003; Moayeri et al., 2017). Table 1 illustrates the typical causes of design changes in the construction industry.

Table 1. The causes of design changes

Factor	Causes
Client's related	● Change of requirement/specification ● Addition/omission of scopes ● Slow decision making ● Unclear initial design brief
Design consultants related	● Erroneous/discrepancies in design ● Have difficulties in capturing client's needs ● Unstructured design process ● Lack of design checking system ● Outdated design due to new technology
Contractor's related	● Request to use available materials ● Alternative construction methods (improving the buildability) ● Lack of experience about new construction technologies ● Use of alternative materials
External related	● Changes in government regulations ● Poor economic conditions ● Differing site conditions ● Unexpected changes in material availability

(Mohamad et al., 2012; Yana et al., 2015; Yap & Skitmore, 2017)

The Integration of VE and BIM

There are many negative effects associated with frequent design changes in construction projects, including poor performance, cost overruns, delays, and the inability to fully function. According to Love et al. (2002), project changes may occur as a result of both internal and external factors. On the other hand, Mohamad et al. (2012) classified the key sources of design changes as clients, consultants, and contractors, who are the primary parties in building construction projects. However, despite the negative impact of design changes, hardly any attention is given to proactively manage these effects, such as through VE and BIM implementation (Kelly & Male, 2003; Moayeri et al., 2017).

VE implementation can be planned during the preparation of the BIM Project Execution Plan (BPEP) to enable seamless project execution. To execute the project, it can be used as a resource. According to JKR Malaysia (2021), BPEP embodies the process and methodology for delivering collaborative working practices for BIM projects. It comes in two forms: pre-contract and post-contract. In pre-contract, information is provided for BIM modelling activities during the design phase, while in post-contract, it is coordinated and managed during construction and operation (JKR Malaysia, 2021). JKR Malaysia (2013) pointed out that two intervention points can be implemented throughout the design phase: VE on concept design and VE on detail design. The use of the BIM model, on the other hand, needs to be adapted to VE intervention in each selected phase, depending on the LOD of the model that has been developed by the designer. Combining VE into the BIM preparation process can be strategically scheduled to promote seamless project execution. As indicated in prior research conducted by Li et al. in 2021, it is conceivable that methods that integrate VE into BIM, focusing on providing clear visualisations and information, can lead to improved overall performance.

Conceptual framework

VE and BIM are combined during design changes at the detailed design stage at LOD300, where design changes frequently occur by using VE, according to the conceptual framework that was developed based on the literature reviews that were conducted. As such, this conceptual framework corresponds to JKR Malaysia (2021), indicating that interactions between the two methods can be more effectively implemented once VE and BIM are integrated during the detailed design phase (LOD300). The integrated approach helps stakeholders understand designs more clearly through 3D visualisation, increases the effectiveness of VE implementation, and provides more transparent and informative design input. Based on the above literature and case studies, there is a need to integrate VE into BIM implementation during the detailed design stage of construction projects.

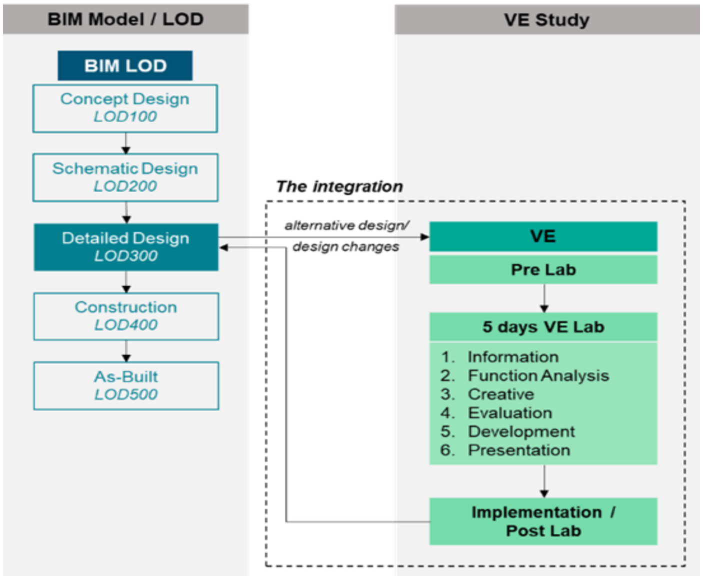


Figure 1. Conceptual framework for VE in BIM combination

METHODOLOGY

Quantitative methodology was adopted to achieve the research's aim and objectives, with a review of the literature incorporated into a questionnaire survey that were distributed to targeted respondents. Online questionnaires are a reasonably rapid and effective method of gathering a large amount of information from a broad sample of practitioners, especially during this COVID-19 pandemic situation. The Statistical Package for Social Sciences (SPSS) was used to analyse the data. The scope of this paper was the integration of VE in BIM. Thus, the respondents contacted were industry experts in VE, BIM, or both. The overall population size for each criterion was based on the organisation's official website, which provides this information. The largest numbers came from members of the Institute of Value Management Malaysia or IVMM, with 248, followed by myBIM Resource Network of CIDB Malaysia (75), BIM Unit, PWD (18), and VM Unit, PWD (12). This gave a total population size of 353 industry experts. To accommodate the large number of respondents, the sampling size for this research was defined using a table developed by Krejcie and Morgan (1970). Therefore, based on the above total population size of 353 (N=353), the required sample size was determined to be 186 (S=186). This paper also sought reassurance and consent from the expert to corroborate the findings at the end of the research.

ANALYSIS AND FINDINGS

From the survey, a total of 32% of responses were received. This rate of responses was higher than the average response rate of 5% to 15% of the questionnaire survey performed in the Malaysian construction industry, according to previous research by Idrus et al. (2018). Figure 2 shows that most respondents were members of IVMM (53.4%), followed by respondents in the myBIM Resource Network List (29.3%). Meanwhile, respondents from the BIM Unit and VM Unit of PWD Malaysia had a proportion of 12.1% and 5.2%, respectively.

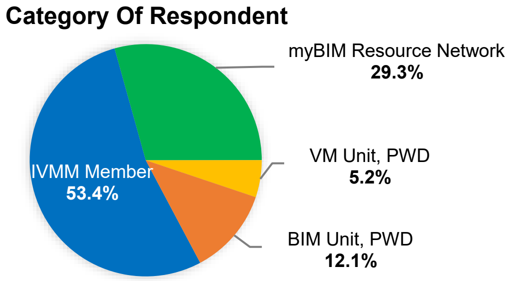


Figure 2. Distribution of respondents' categories

Meanwhile, Figure 3 indicates that industry practitioners agreed that VE can improve project development to achieve the best value for money, giving earlier consideration to design, buildability, and maintainability. Additionally, they disagreed that the implementation costs for VE are very high. It was also found that VE application maturity in Malaysia is at the Managed Level, which signifies that the organisation has implemented effective strategies and processes in accordance with its medium- and long-term goals. The findings of the research also highlighted that the application of BIM improves visualisation for construction projects, increases coordination of construction documents, and enhances productivity due to easy retrieval of information. Moreover, the BIM application maturity level in Malaysia was found to be at Level 2 (Collaboration), which indicates that the industry is currently developing building information in a collaborative 3D environment with data attached but in separate discipline models. Such findings are updated information, of which Sinoh et al. (2020) indicated that there was a transition from Level 1 to Level 2.

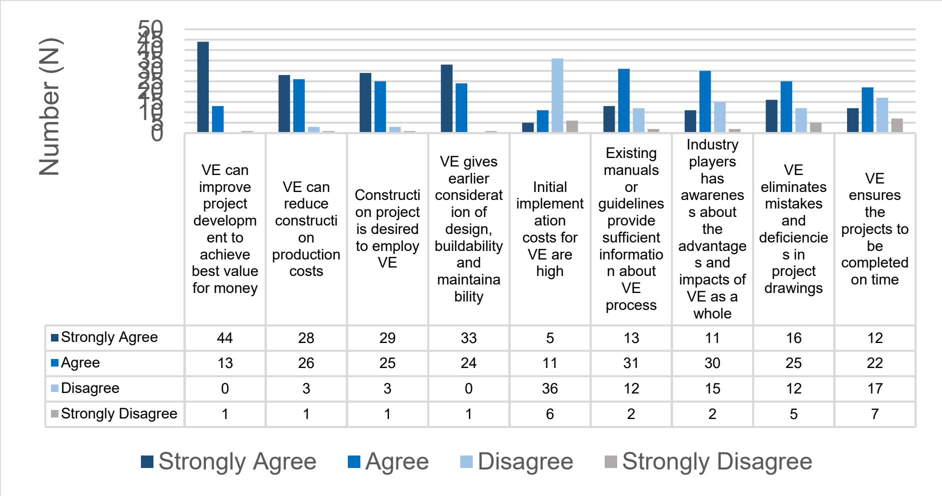


Figure 3. VE/VM application in Malaysia

Many organisations do not have a systematic or structured process for accommodating design changes and only conduct review exercises. Based on the analysis, most industry practitioners agreed that the Malaysian construction industry is ready to adopt the approach of incorporating VE into BIM. The industry practitioners also highlighted the justification and reasons for its readiness to integrate, stating that the construction industry has embraced both methods and integration can give value for money while also complying with government policies. Additionally, they believed that the results from the integration of VE in BIM have the potential to provide positive outcomes and impacts to stakeholders. Furthermore, according to industry practitioners, integrated approaches can benefit and complement each other, while creating opportunities for everyone to improve the standard of work in the construction industry.

Table 2. The Malaysian construction industry's readiness to integrate VE in BIM

			Respondents' knowledge and understanding			Total
			VE/VM	BIM	Both	
Readiness for integrating VE into BIM	Yes	Count	13	2	25	40
		%	68.4%	66.7%	69.4%	69.0%
	No	Count	6	1	11	18
		%	31.6%	33.3%	30.6%	31.0%

As the majority of industry practitioners, with almost 70% of respondents (Table 2), believe that the Malaysian construction industry is ready to integrate VE into BIM, the essential elements in developing the integration framework are found to be as follows:

Table 3. Essential elements to develop VE in BIM integration framework

Essential Elements	Industry's Input
Value approach that best apply	Reducing the cost and at the same time increasing the function and quality (known as 'Compound Approach')
Most efficient parties to be involved	Client, Design Consultant, Quantity Surveyor, Civil Engineer, Structural Engineer, Mechanical Engineer & Electrical Engineer
Key project documents	Cost estimation, design drawing and specifications
Optimal duration	More than 5 days (> 5 days)
VE method to be adopted	5 days VE Lab/Workshop
Issues arise in BIM implementation that VE can manage	High project cost and deficiency in construction quality
Potential outcome from the integration	Cost optimisation, achieve value for money and improve the performance in BIM process

CONCLUSION

Using the suggested approach, this paper provides benefits and guidance for construction practitioners interested in making design changes. This approach may improve efficiency, cost optimisation, or the performance of the BIM process. This paper also provides an overall perspective on how VE can be implemented with BIM during the detailed design stage of a construction project, as depicted in Figure 4. Through the output of the discussion, practitioners can assess the level of application and maturity of VE and BIM in Malaysia. Furthermore, practitioners may define the critical factors driving design changes, as well as approaches to overcome them through the application of a structured process, which is the best option. It is possible to increase industry awareness of the practicability of the integration approach by evaluating the integration of VE into BIM during the detailed stages of a construction project. Furthermore, the VE framework in BIM during the detailed design stage is developed based on the opinions and perceptions of industry practitioners. As a result, practitioners can proactively implement this systematic process to accommodate design changes.

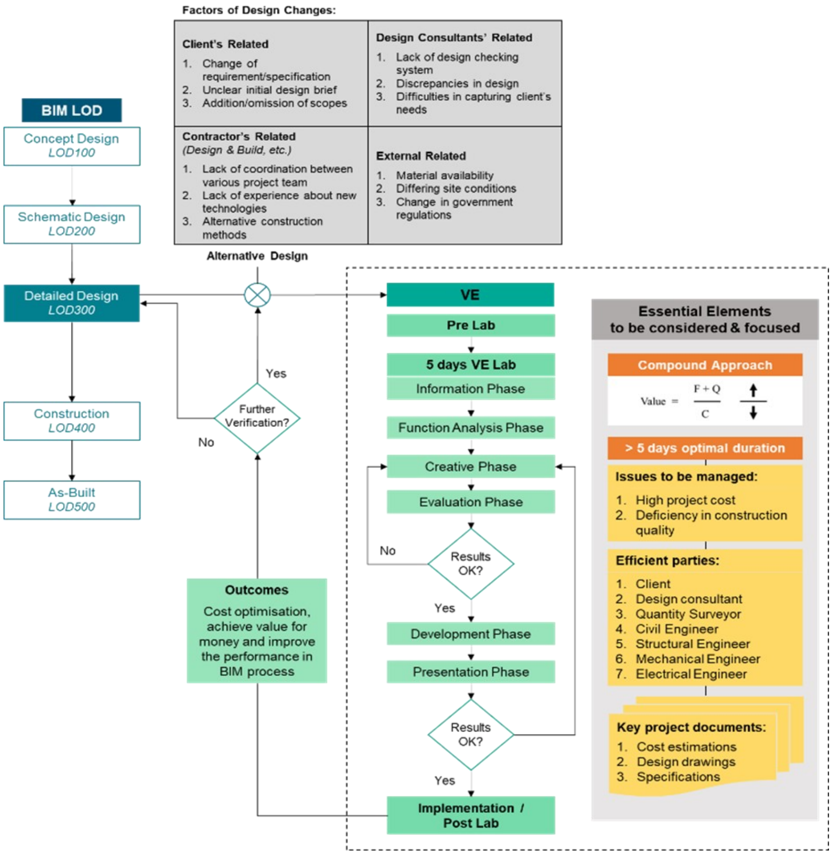


Figure 4. The integration of VE in BIM framework

REFERENCES

Abbasnejad, B., Nepal, M. P., Ahankoob, A., Nasirian, A., & Drogemuller, R. (2021). Building Information Modelling (BIM) adoption and implementation enablers in AEC firms: a systematic literature review. *Architectural Engineering and Design Management, 17*(5-6), 411-433. https://doi.org/10.1080/17452007.2020.1793721

Abd-Karim, S. B. (2016). The application of value management on private projects. QSLink. *Board of Quantity Surveyors Malaysia Bulletin*, 33-36.

Abd-Karim, S. B., Lowe, D., Abdul-Rahman, H., Wang, C., Yahya, I., & Shen, G. (2011). Integrating risk and value management using IRVM workshops: Case studies in infrastructure projects in UK. Scientific research and essays, 6, 2470-2479.

Baarimah, A.O, Alaloul, W. S., Liew, M. S., Al-Aidrous, A. -H. M. H., Alawag, A. M. and Musarat, M. A. (2021). Integration of Building Information Modeling (BIM) and Value Engineering in Construction Projects: A Bibliometric Analysis. Third International Sustainability and Resilience Conference: Climate Change, Sakheer, Bahrain, 2021, pp. 362-367, doi: 10.1109/IEEECONF53624.2021.9668045.

Bentley. (2017). How AIA partner Bentley's BIM applications designed the world-class architecture of One Blackfriars. https://www.aia.org/articles/164986-design-innovation-for-large-scale-projects

Bryde, D., Broquetas, M., & Volm, J. M. (2013). The project benefits of Building Information Modelling (BIM). *International Journal of Project Management, 31*(7), 971-980. https://doi.org/https://doi.org/10.1016/j.ijproman.2012.12.001

Che Mat, M. M. (2010). Value management–the way forward. Seminar Achieving Better Value In Construction Industry Through Value Management & Life Cycle Cost. Organized by CIDB. Putrajaya,

Dcrnirdogen, G., Diren, N. S.,. Aladag, H. and Isik, Z. (2021). Lean Based Maturity Framework Integrating Value BIM and Big Data Analytics: Evidence from AEC Industry. *Sustainability, 13*(18), pp10029, Sep. 2021.

Economic Planning Unit (EPU). (2011). Implementation Guidelines for The Value Management in The Government Programmes/Projects. https://www.epu.gov.my/en

Faraj, I., Alshawi, M., Aouad, G., Child, T., & Underwood, J. (2000). An industry foundation classes Web-based collaborative construction computer environment: WISPER. *Automation in Construction, 10*(1), 79-99.

Farouk, A. M., Zulhisham, A. Z., Lee, Y. S., Rajabi, M. S., & Rahman, R. A. (2023). Factors, Challenges and Strategies of Trust in BIM-Based Construction Projects: A Case Study in Malaysia. *Infrastructures, 8*(1), 13. MDPI AG. Retrieved from http://dx.doi.org/10.3390/infrastructures8010013

Haron, A. T., Marshall-Ponting, A. J., Zakaria, Z., Nawi, M. N. M., Hamid, Z., & Kamar, K. A. M. (2015). An industrial report on the Malaysian building information modelling (BIM) taskforce: issues and recommendations. *Malaysian Construction Research Journal, 17*(2), 21-36.

Haron, N. A., Raja Soh, R. P. Z. A., & Harun, A. N. (2017). Implementation of Building Information Modelling (BIM) in Malaysia: A Review. *Pertanika Journal of Science & Technology, 25*(3).

Idrus, A., Hashim, K., & Farah, A. M. (2018). Towards Development of a Database for Civil and Structural Construction Works' Production Rates.

IVMM. (2018). National Value Management Guide. Institute of Value Management Malaysia (IVMM).

IVMM. (2021). Value Management Competency Standard. Institute of Value Management Malaysia (IVMM).

Izadi Moud, H., & Abbasnejad, B. (2012). BIM and Basic challenges Associated with its Definitions, Interpretations and Expectations. *International Journal of Engineering Research and Applications*, 3, 292.

Jaapar, A. (2008). Value management study to the Malaysian construction industry. Proceedings of the 3rd BEAN Conference,

Jaapar, A., Maznan, N., & Zawawi, M. (2012). Implementation of Value Management in Public Projects. *Procedia - Social and Behavioral Sciences*, 68, 77–86. https://doi.org/10.1016/j.sbspro.2012.12.208

Jaapar, A., & Torrance, J. (2007). Prototype Value Management Guidelines for the Malaysian Construction Industry. In: Crown Plaza Mutiara Hotel Kuala Lumpur, Malaysia.

JKR Malaysia. (2013). Value Engineering Application Guidelines for Public Projects. In Cawangan Pengurusan Projek Kompleks (PROKOM) Jabatan Kerja Raya (JKR) Malaysia (Ed.). Kuala Lumpur.

JKR Malaysia. (2021). BIM: Kit VE (1 ed.). Unit Building Information Modelling, Bahagian Pengurusan Projek Kompleks, Cawangan Perancangan Aset Bersepadu.

Kelly, J., & Male, S. (2003). Value management in design and construction. Routledge.

Kelly, J., Male, S., & Graham, D. (2014). Value management of construction projects. John Wiley & Sons.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and psychological measurement, 30*(3), 607-610.

Latiffi, A. A., Brahim, J., Mohd, S., & Fathi, M. S. (2015). Building information modeling (BIM): exploring level of development (LOD) in construction projects. applied mechanics and materials,

Latiffi, A. A., Mohd, S., Kasim, N., & Fathi, M. S. (2013). Building information modeling (BIM) application in Malaysian construction industry. *International Journal of Construction Engineering and Management, 2*(4A), 1-6.

Lévy, F. (2011). BIM in small-scale sustainable design. John Wiley & Sons.

Li, J., Hou, L., Wang, X., Wang, J., Guo, J., Zhang, S., & Jiao, Y. (2014). A Project-Based Quantification of BIM Benefits. *International Journal of Advanced Robotic Systems, 11*(8), 123. https://doi.org/10.5772/58448

Li, X., Wang, C., & Alashwal, A. (2021). Case Study on BIM and Value Engineering Integration for Construction Cost Control. *Advances in Civil Engineering*, 2021, 8849303. https://doi.org/10.1155/2021/8849303

Love, P. E., Holt, G. D., Shen, L. Y., Li, H., & Irani, Z. (2002). Using systems dynamics to better understand change and rework in construction project management systems. *International Journal of Project Management, 20*(6), 425-436.

Male, S., Kelly, J., Gronqvist, M., & Graham, D. (2007). Managing value as a management style for projects. *International Journal of Project Management*, 25, 107-114. https://doi.org/10.1016/j.ijproman.2006.09.001

Migilinskas, D., Popov, V., Juocevicius, V., & Ustinovichius, L. (2013). The benefits, obstacles and problems of practical BIM implementation. *Procedia Engineering*, 57, 767-774.

Moayeri, V., Moselhi, O., & Zhu, Z. (2017). Design change management using BIM-based visualization model. *International Journal of Architecture, Engineering and Construction, 6*(1), 1-11.

Mohamad, M. I., Nekooie, M. A., Al-Harthy, A. B. S., & Amur, B. (2012). Design changes in residential reinforced concrete buildings: The causes, sources, impacts and preventive measures. *Journal of Construction in Developing Countries, 17*(2), 23-44.

Nath, T., Attarzadeh, M., Tiong, R. L., Chidambaram, C., & Yu, Z. (2015). Productivity improvement of precast shop drawings generation through BIM-based process re-engineering. *Automation in Construction*, 54, 54-68.

Park, C.-S., Kim, H.-J., Park, H.-T., Goh, J.-H., & Pedro, A. (2017). BIM-based idea bank for managing value engineering ideas. *International Journal of Project Management, 35*(4), 699-713.

RICS. (2017). Value Management and Value Engineering. Royal Institution of Chartered Surveyors (RICS).

Rosenman, M. A., Smith, G., Maher, M. L., Ding, L., & Marchant, D. (2007). Multidisciplinary collaborative design in virtual environments. *Automation in Construction, 16*(1), 37-44.

Saraireh, A., Moh'd, I., & Haron, A. T. (2020). Understanding the Conceptual of Building Information Modeling: A Literature Review. *International Journal of Civil Engineering and Technology, 11*(1), 165-171.

SAVE International. (2015). Value Methodology Standard. https://www.value-eng.org/

Sinoh, S. S., Ibrahim, Z., Othman, F., & Muhammad, N. L. N. (2020). Review of BIM literature and government initiatives to promote BIM in Malaysia. *IOP Conference Series: Materials Science and Engineering*, 943(1), 012057. https://doi.org/10.1088/1757-899x/943/1/012057

Succar, B. (2009). Building information modelling framework: A research and delivery foundation for industry stakeholders. *Automation in Construction, 18*(3), 357-375.

Thomas, L. (2019). How Value Engineering is Used in Construction Projects. Project Cost Solutions.

United BIM (2023). A practical approach to Level of Detail (LoD). https://www.united-bim.com/practical-approach-to-level-of-detail/. Accessed on September 15, 2023.

Wao, J. (2015). A Review of the Value Engineering Methodology: Limitations and Solutions for Sustainable Construction. https://doi.org/10.13140/RG.2.1.5183.0884

Wei, T., & Chen, Y. (2020). Green building design based on BIM and value engineering. *Journal of Ambient Intelligence and Humanized Computing, 11*(9), 3699-3706. https://doi.org/10.1007/s12652-019-01556-z

Received: 7th June 2023. Accepted: 5th September 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 78 – 95

KEY FACTORS INFLUENCING THE FAMILY-FRIENDLY NEIGHBOURHOOD THROUGH PLS-SEM MODEL ASSESSMENT. CASE STUDY: SS4, PETALING JAYA, SELANGOR, MALAYSIA

Siti Fatimah Hashim[1], Na'asah Nasrudin[2], Raja Norashekin Raja Othman[3], Yusfida Ayu Abdullah[4], Mohd Zahid Mohd Salleh[5]

[1] *Center of Postgraduate Studies, Faculty of Architecture, Planning and Surveying*
UNIVERSITI TEKNOLOGI MARA, SHAH ALAM, SELANGOR, MALAYSIA
[2,3,4] *Centre of Studies for Town and Regional Planning,*
Faculty of Architecture, Planning and Surveying
UNIVERSITI TEKNOLOGI MARA, PUNCAK ALAM, SELANGOR, MALAYSIA
[5] *Centre of Studies for Landscape Architecture,*
Faculty of Architecture, Planning and Surveying
UNIVERSITI TEKNOLOGI MARA, PUNCAK ALAM, SELANGOR, MALAYSIA

Abstract

Urbanisation brought about by advances in human civilisation affects the daily life of the people. The rising trend in the percentage of dual-earner households had created many problems for families living in cities. This has resulted in challenges of work-life balance, caregiving demands in raising children and dependents as well as running a household, and physical and social environment issues in the urban neighbourhood. The cities should be designed to accommodate the needs of families in terms of public facilities and social capital within the neighbourhood and the nearby surrounding urban areas. Hence, this study aimed to assess the relationship between physical and social environment factors within the local community in the study area through 248 questionnaire survey distributed to the head of household as a target group of this study via systematic and stratified sampling. The modelling analysis revealed that, social environment factor is the main factor that most positively influences the level of family-friendly neighbourhood than the physical environment factor in terms of trusted, willing to help, feel connected, get along with one another, give support, close-knit neighbourhood and share same value among families and communities in the study area. Thus, the needs of urban families and communities towards social capital should be taken into consideration in the study area, specifically.

Keywords: Family-friendly Neighbourhood; Physical Environment (Public Facilities); Social Environment (Social Capital)

[2] Senior Lecturer at Universiti Teknologi MARA. Email: naasa717@uitm.edu.my

INTRODUCTION

Urbanisation is a process of change and application of urban characteristics to an area and this process will involve inward migration of rural population, changes in activities, economy, development of urban areas, increased provision of public facilities, social change, values and nature of traditional society to modern society as well as land-use change as a whole (National Physical Plan-3, 2016). These factors have encouraged families to live in the city nowadays. The target of 46.1 million population by 2040 has led to several challenges and issues of urbanisation in Malaysia, especially for families with children and dependents living in cities. The rapid urbanisation has led to an increase in the cost of living and high living standards in cities cause challenges for families to manage their children and dependents – there is a lack of social facilities and affordable community services in the cities, work-life balance, caregiving demands and physical and social environment issues in the urban neighbourhood. In addition, the era of a covid-19 pandemic that has hit around the world since 2019, including Malaysia has caused the families in the city to be increasingly impacted.

In 2021, the Fourth National Physical Plan (National Physical Plan-4, 2021) has been establishing a distinct national physical planning pattern. This involves creating targeted strategies and implementing actions related to various aspects, such as land use development, economic growth, resource conservation and management, enhancement and integration of the national transportation network and infrastructure, and overall improvement of the country's quality of life and well-being. Hence, cities should be designed to accommodate the needs of families in terms of public facilities and social capital within the neighbourhood and the nearby surrounding urban areas. The availability and accessibility of this physical and social environment in urban neighbourhoods have to some degree affected the well-being of families. Therefore, in line with the needs of urban families' issues and scenarios, this research focuses on assessing the relationship between physical environment (public facilities) and social environment (social capital) factors within the local community in the study area as the main aim of this study.

FAMILY-FRIENDLY NEIGHBOURHOOD

The family-friendly neighbourhood is not a new concept. Israel, E. and Warner, M. E. (2008) in a 2008 national survey conducted by the American Planning Association (APA) revealed that a "family-friendly community is a community where families enjoy housing at an affordable price, child care, park to play in, pedestrian pathways, quality of public schools and safe neighbourhood, among many other potential features that promote family well-being". Rukus, J. and Warner, M. E. (2013) found that family-friendly initiatives typically consist of better urban design to promote walkability, improved parks and recreation services, housing options that accommodate the entire spectrum of income levels and increased access to quality child care and youth services. The combination of planning, design and community participation forms the nexus of a child-friendly, family-friendly and age-friendly city.

In 2008, the American Planning Association (APA) published a Planning Advisory Service Memo on Planners' role in creating Family-friendly Communities which focuses on the importance of families to communities and the role planners can play in designing communities that better meet families' needs by questioning "shouldn't we as planners, also be concerned with planning communities for people from childhood to old age?". Based on the survey of practising planners across the United States found that "… planners have important tools at their disposal to promote more family-friendly cities. They can remove zoning barriers to accessory apartments or child care, design transportation systems to address family needs, use state and federal funds for child care, promote affordable housing, provide safe and attractive parks…" (Israel, E. and Warner, M., 2008: 14). This indicates that planners play an important role in determining the formation of a family-friendly neighbourhood by taking into account on town planning point of view. In essence, town planning is an art and science of shaping the built environment we live in with the objective of creating a comfortable, safe, convenient and healthy environment (Karim, A. H., 2008).

In the Malaysian perspective, there are a number of studies related to the concept of family-friendly neighbourhood. A study on family well-being in Malaysia by Noor, N. M. et al. (2012) identified ten key indicators that can predict family well-being and another study by Hashim, S. F. et al. (2020) which reviewed family-friendly neighbourhoods in the Malaysian perspective revealed that there are four main themes which are family-friendly community, and/or environment, social capital, urban neighbourhood and quality of life. Thus, based on the literature review, the physical (public facilities) and social (social capital) environments to be examined in this study were defined. On this basis, the following hypotheses, which are clearly illustrated in Figure 1, were set out to further research purposes:

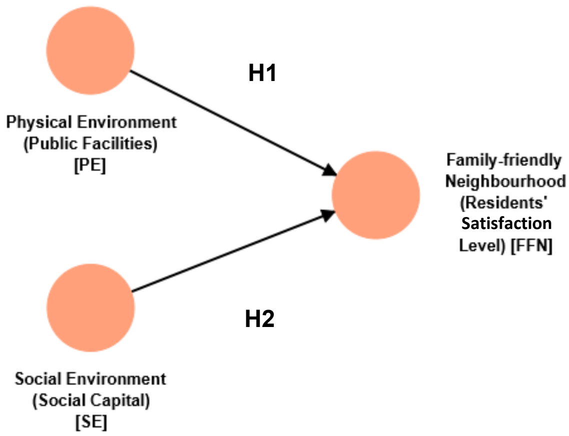


Figure 1: Hypotheses of the Model's Study

RESEARCH METHODOLOGY

The aim of this study is to assess the relationship between physical environment (public facilities) and social environment (social capital) factors within the local community in the study area. The target of this study is the heads of the family (head of household) residing in SS4, Petaling Jaya, Selangor. The study utilised probability sampling methods, specifically systematic sampling and stratified sampling. A questionnaire survey was used as a research approach of this study. For the adequacy of the sample size of this study, the Raosoft Sample Size Calculator was used to confirm the suitability of the samples: 319 sample size based on 1874 total number of houses (as a population size), 95% confidence level and 5% margin error. The sample of 319 participants was divided into two strata based on the housing types, namely detached or bungalow houses, and semi-detached and terrace houses. However, due to the unwillingness of the head of household to participate in this questionnaire survey, the total number of questionnaire survey responses from the residents was 248 out of 319 sample size. Figure 2 shows the site plan and existing surrounding area.

Figure 2: Site Plan and Existing surrounding area

The analysis of the reliability and validity of the model measure was carried out through partial least squares-structural equation modelling (PLS-SEM) analysis by using SmartPLS software application. In evaluating the PLS-SEM models, the reliability (the measurement instruments are free of random errors) and validity (the dimensions have the capacity to show real differences between the object as related to the characteristic being measured) (Abu, F. et al., 2021) have been examined in this study. Besides, the PLS-SEM analysis was executed to test: firstly, the measurement model (was tested to validate the instruments) and secondly, the structural model (was examined to test the hypothesis). Figure 3 show the two stages of PLS-SEM and assessments.

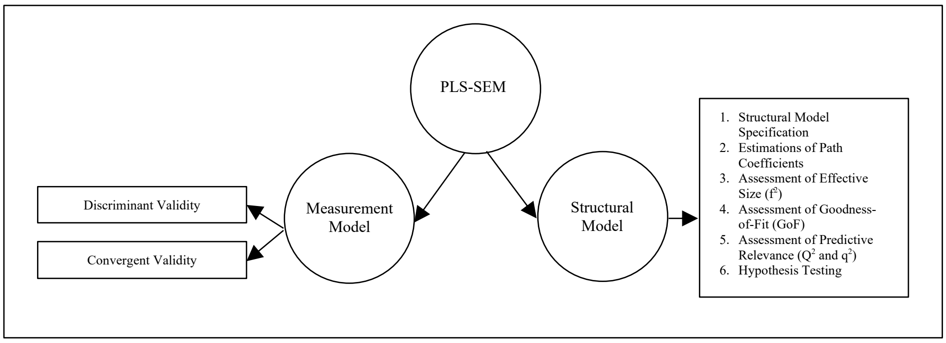


Figure 3: Two stages of PLS-SEM and assessments (adopted: Hassan, M. A., 2020)

This study focused on the second-order construct that includes formative relationships (reflective-formative, Type II) (Abu, F. et al., 2021). The conceptual model has two first-order constructs: Physical environment (Public Facilities) [PE] and Social environment (Social Capital) [SE] and one second-order construct: Family-friendly Neighbourhood (Residents' Satisfaction Level) [FFN]. A repeated indicator approach was used to estimate the construct scores of a second-order construct because the observed indicators do not exist. Table 1 and Figure 4 shows the item loadings and conceptual model with items of every latent constructs.

Table 1: The Item Loadings

Model Construct	Measurement Item	Item Represent
Physical Environment (Public Facilities and Amenities)	PE 1	Fully utilised
	PE 2	Sufficient
	PE 3	Good condition/Quality
	PE 4	Accessible
	PE 5	Provided the design for people with disability (PWD)/user-friendly/child-friendly
	PE 6	Maintenance
Social Environment (Social Capital)	SE 1	Trusted
	SE 2	Willing to help
	SE 3	Feel connected
	SE 4	Get along with one another
	SE 5	Help out as volunteer
	SE 6	Give support
	SE 7	Close-knit neighbourhood
	SE 8	Share same value e.g. knowledge, communication, productivity and sustainability
	SE 9	Crime rate

Note: PE (Physical Environment: Public Facilities); and SE (Social Environment: Social Capital)

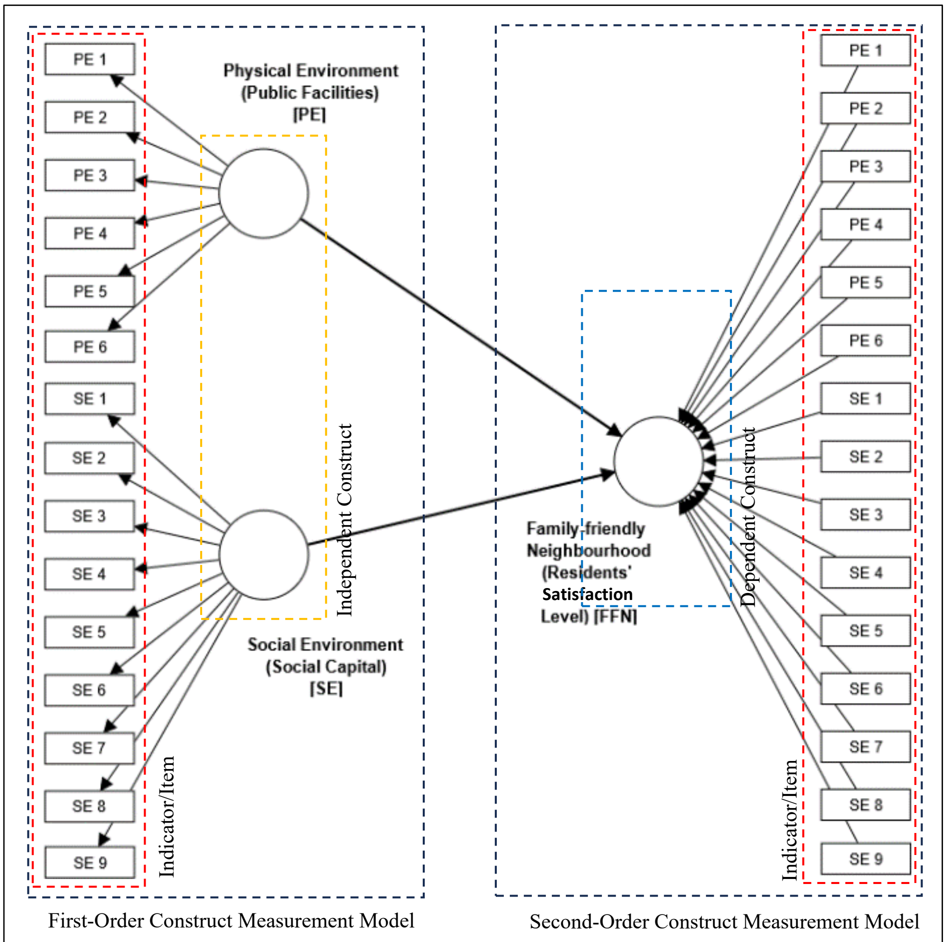


Figure 4: Conceptual Model with Items of every Latent Constructs

The methods of reporting PLS-SEM were described in two-tiers. The first-tier is by reporting the assessing the second-order construct in PLS-SEM and the second-tier entails reporting the rules of thumb in evaluating the PLS-SEM models. There are two independent (Physical Environment (Public Facilities and Amenities) [PE] and Social Environment (Social Capital) [SE] and one dependent Family-friendly Neighbourhood (Resident's' Satisfaction Level) [FFN] variables that have been measured in this study.

FINDINGS AND DISCUSSION

How does public facilities and social capital positively influence the level of family-friendliness in the study area? The PLS-SEM model assessment has been used to verified the hypotheses of this study.

- **H1:** Physical Environment (Public Facilities) [PE] has significantly positive influence on Family-friendly Neighbourhood [FFN]
- **H2:** Social Environment (Social Capital) [SC] has significantly positive influence on Family-friendly Neighbourhood [FFN]

Assessment of the Measurement Model

The proposed models had an uneven number of indicators for the first-order constructs and used the formative construct repeated indicator approach with a path weighting scheme on the second-order constructs. The analysis began with an assessment of the measurement models. Following the recommendations of Amin, M. et al. (2016), the CV was assessed using factor loadings, average variance extracted (AVE) and composite reliability (CR). The recommended values for loadings were set at > 0.5, CR at > 0.7, and AVE at > 0.5. Figure 3 shows the measurement model results.

Specifically, the factor loadings were assessed first. The results showed that all of the reflectively measured constructs were above the threshold of 0.5. Each item's loading on its underlying construct was above the recommended values of 0.5 (Amin, M. et al., 2016; Jayasingam, S. et al., 2018) and 0.6 (Kashif, M. et al., 2018; Rezaei, G. et al., 2016). Lower loading items i.e. PE 6 (0.378): maintenance, SE 5 (0.422): help out as volunteer and SE 9 (0.573): crime rate – were dropped to obtain better reliability and discriminant validity.

Next, the CR was examined. The CR varied between 0 and 1. According to Hair, J. F. et al. (2019) and Gholami, H. et al. (2016), CR values of above 0.7 were still considered satisfactory and none of the CR values were above 0.9 which is an undesirable value. All the CRs had values above 0.8 (Gholami, H. et al., 2016; Vinzi, E. et al., 2010; Scholtz, B. et al., 2016). The internal consistency reliability (after bootstrap) for all the constructs' reliability was considerably higher (lower) than the suggested minimum (maximum) thresholds (p-values < 0.01).

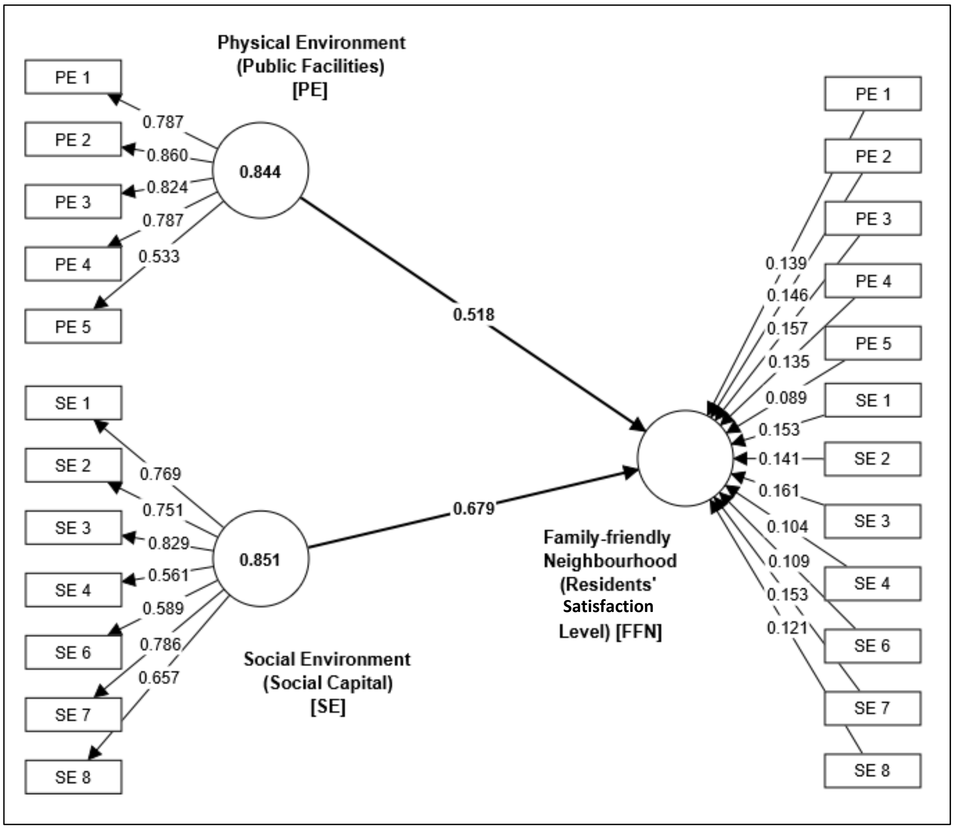


Figure 5: Measurement Model Results

Then, all the AVE assessed were higher than the critical value of 0.5 (Xue, Y. et al., 2011; Rezaei, G. et al., 2016; Scholtz, B. et al., 2016). This indicates that the main constructs capture more construct-related variance than error variance (Xue, Y. et al., 2011). As presented in Table 2, the measurement model's results surpassed the proposed values hence suggesting adequate convergence validity.

Table 2: The Measurement Model of First-Order Constructs (Reflective)

Model Construct	Measurement Item	Loadings	AVE	CR
Physical Environment (Public Facilities)	PE 1	0.787	0.588	0.844
	PE 2	0.860		
	PE 3	0.824		
	PE 4	0.787		
	PE 5	0.533		
Social Environment (Social Capital)	SE 1	0.769	0.508	0.851
	SE 2	0.751		
	SE 3	0.829		
	SE 4	0.561		
	SE 6	0.589		
	SE 7	0.786		
	SE 8	0.657		

Note: PE (Physical Environment: Public Facilities); and SE (Social Environment: Social Capital), Adapted from Abu, F. et al. (2021)

Finally, after confirming the CV, the DV was assessed using the HTMT method. The DV assessment shows that all the HTMT values were significantly lower than 0.9 (Table 3). The constructs were distinct from each other because they were below the suggested cut-off of 0.90 (Xue, Y. et al., 2011; Tehseen, S et al., 2017). Bootstrapping determines the significant difference of the HTMT value from 1.00 (Henseler, J. et al., 2015). All the HTMT values were significantly lower than the threshold value and different from 1.00.

Table 3: Heterotrait-Monotrait Ratio (HTMT) of First-order Construct (FOC)

	1	2
1. PE	0.767	
2. SE	0.386	0.712

Note: PE (Physical Environment: Public Facilities); and SE (Social Environment: Social Capital), Adapted from Salleh, M. Z. M. (2022)

Based on Figure 4, the Family-friendly Neighbourhood (Resident's' Satisfaction Level) [FFN] was conceptualized as formative second-order constructs. The repeated indicator approach for modeling the second-order factors in the PLS analysis (Amin, M. et al., 2016; Abu, F. et al., 2021) did not report on the predictive relevance, Q^2 or effect sizes, f^2. The formative measurements were confirmed by the VIF and path weight (Table 4). Firstly, all the predictor constructs' VIF values were assessed to ensure that there is no collinearity issue between the constructs' formative indicators (Tehseen, S et al., 2017). As all of the VIF values were below the more conservative threshold of 3.3 (Duarte, P. and Amaro, S., 2018; Scholtz, B. et al., 2016), the results presented ideal VIF values (VIF < 3) indicating no multi-collinearity problems.

Table 4: The Measurement Model of Second-level Constructs (Formative)

Constructs	Collinearity (Inner VIF)	Statistical Sig. of Weights	*p*-Value	Confidence Intervals	
				2.5%	97.5%
PE	1.175	0.518	0.000	0.487	0.553
SE	1.175	0.679	0.000	0.644	0.713

Note: PE (Physical Environment: Public Facilities); and SE (Social Environment: Social Capital), Adapted from Abu, F. et al. (2021)

Next, the indicators' weights were assessed by bootstrapping to verify their significance. Each indicator's weight significance indicates the relative significance whilst the loading indicates the total significance which is measurable using bootstrapping (Tehseen, S. et al., 2017). All the statistical significances of weights were higher than 0.1 (Tehseen, S et al., 2018), the p-value was below 0.01 and the 97.5% confidence interval (based on the BCa method) did not include zero (Hair, J. F. et al., 2019).

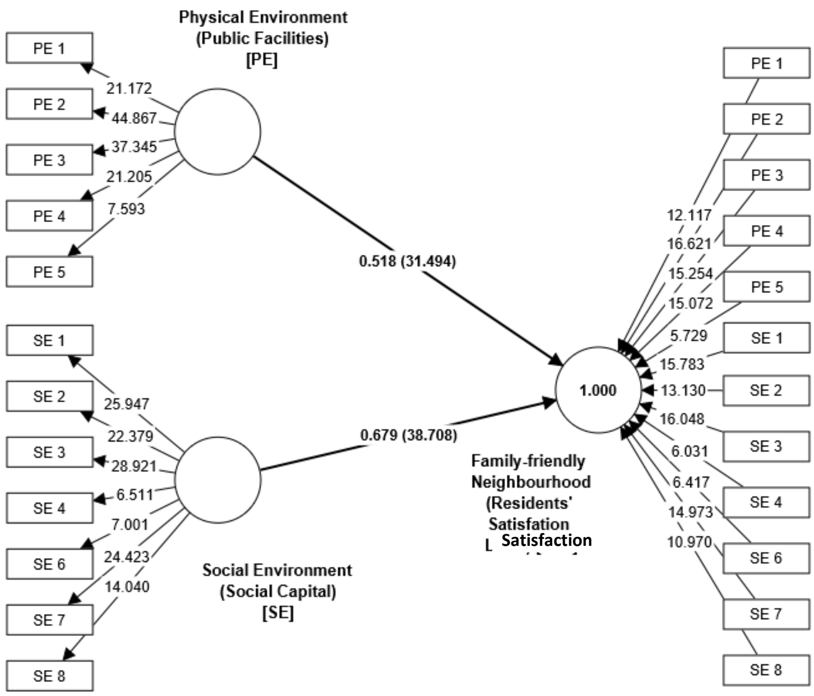


Figure 6: Bootstrapping Results (Note: Hypothesis testing of bootstrapping procedure using 5000 resamples; inner model shows path coefficients and t-values; outer model shows *t*-values and construct shows R-square value)

Assessment of the Structural Model

The R^2 was calculated to evaluate the structural models' predictive power (Amin, M. et al., 2016; Gholami, H. et al., 2016), as presented in Figure 4. By using the repeated indicator approach, all the variances of the higher order construct R^2 were equal to 1 (Becker, J. M., et al., 2012) for the Family-friendly Neighbourhood (FFN) constructs. This is because the R2 indicated the amount of variance explained by the exogenous variables (Amin, M. et al., 2016).

Next, the path analysis was carried out to test the hypotheses generated. The results of the bootstrapping procedure with 5000 samples and using the no sign changes option (Shmueli, G. et al., 2019) revealed that all of the structural model relationships were significant. Table 5 shows the structural model analysis. Specifically, strong and significant statistical evidence was acquired for hypothesis H1 (PE -> FFN, $\beta = 0.518$, $p < 0.000$) and H2 (SE -> FFN, $\beta = 0.679$, $p < 0.000$) in this study. Thus, the findings indicated that the Physical Environment (Public Facilities) and Social Environment (Social Capital) have a positive influence on the Family-friendly Neighbourhood (Residents' Satisfaction Level) constructs.

Table 5: Direct Relationships for Hypothesis Testing

Hypothesis	**Path Co-Efficient (β)**	**Standard Deviation**	***t*-Value**	***p*-Value**	**Bias Confidence Intervals (BCI)**		**Results**
					2.5%	**97.5%**	
H1: PE -> FFN	0.518	0.016	31.494	0.000	0.490	0.557	Supported
H2: SE -> FFN	0.679	0.018	38.708	0.000	0.647	0.716	Supported

Note: PE (Physical Environment: Public Facilities); SE (Social Environment: Social Capital); and Family-friendly Neighbourhood (Resident's' Satisfaction Level) [FFN] Adapted from Abu, F. et al. (2021)

Next, the Q^2 value was examined because this measure is an indicator of the model's predictive relevance (Amin, M. et al., 2016). Amin, M. et al. (2016) by referring to Hair, J. F. et al. (2014) indicated that "PLS-SEM exhibits predictive relevance; it can accurately predict the data points of indicators in reflective measurement models of endogenous construct and endogenous single-item constructs". The predictive relevance or Q^2 analysis was conducted via blindfolding with a distance value of 6 (Samuel, R. and Ramayah, T., 2016). A Q^2 value greater than 0 indicates adequate predictive relevance for the model (Amin, M. et al., 2016). The Q^2 for Family-friendly Neighbourhood (FFN) was 1.000. The values represented a predictive relevance for the endogenous construct or predictive accuracy of the PLS path model. However, the indicators for the endogenous constructs (Family-friendly Neighbourhood) are repeated indicators. The root means squared error (RMSE) value for the linear regression model is 0, indicating that the model lacks predictive power (as PLS-SEM < linear regression model for none of the indicators) (Shmueli, G. et al., 2019). Thus, it was not appropriate to compare each of the indicator's RMSE value with the linear regression model value and to report the PLS to predict.

Summary on PLS-SEM result for the Family-friendly Neighbourhood

The result of PLS-SEM for Family-friendly Neighbourhood is primarily to show the strength of the study through the relationship between independent (Physical Environment: Public Facilities and Social Environment: Social Capital) and dependent (Family-friendly Neighbourhood: Resident's' Satisfaction Level) variables of this study. Table 6 shows the summary of measurement and structural model.

Table 6: The Summary of Measurement and Structural Model

No.	Testing	Description	PLS-SEM Result
Reflective Measurement Model			
Convergent Validity (CV)			
1.	Reflective indicator loading	Values for loadings are set at > 0.5	All constructs had agreeable values > 0.5 except for 3 constructs had a lower loadings item i.e. PE 6 (0.378), SE 5 (0.422) and SE 9 (0.573) were dropped to obtain better reliability and discriminant validity
2.	Composite Reliability (CR)	Recommended CR values within 0.70 – 0.90 are satisfactory	All constructs are > 0.8
3.	Average Variance Extracted (AVE)	AVE for each construct should be > 0.5	All constructs are > 0.5
Discriminant Validity (DV)			
4.	Heterotrait-monotrait ratio of correlations (HTMT)	a. For conceptually similar constructs: HTMT < 0.90 b. For conceptually different constructs: HTMT < 0.85	All the HTMT values were significantly lower than the threshold value and different from 1.00
Formative Measurement Model			
5.	Variation Inflation Factor (VIF)	a. Probable (i.e., critical) collinearity issues when VIF > 5 b. Possible collinearity issues when VIF > 3-5 c. Ideally show that VIF < 3	As all of the VIF values were below the more conservative threshold of 3.3 (Duarte, P. and Amaro, S., 2018; Scholtz, B. et al., 2016), the results presented ideal VIF values (VIF < 3)

			indicating no multi-collinearity problems
6.	Statistical Significance of Weights	*p*-value < 0.05 or the 95% confidence interval (based on the percentile method or in case of a skewed bootstrap distribution, the BCa method) does not include zero	*p*-value < 0.000
Structural Model			
7.	Coefficients of Determination (R^2)	R^2 result is equal to 1 for repeated indicator approach	All the variances of the higher order construct R^2 were equal to 1
8.	Q^2 Value	a. Blindfolding-based cross validated redundancy measure (Q^2) b. Values higher than zero denote meaningful c. Values larger than 0, 0.25 and 0.50 indicate small, medium and large predictive accuracy of the PLS path model	FFN = 1.000 (large predictive accuracy of the PLS path model but the indicators for the endogenous constructs (Family-friendly Neighbourhood) are repeated indicators.
9.	PLS Predict	Q^2 predict values > 0 indicate that the model outperforms the most naïve benchmark (i.e., the indicator means from the analysis sample)	The linear regression model is 0, indicating that the model lacks predictive power (as PLS-SEM < linear regression model for none of the indicators). Thus, it was not appropriate to compare each of the indicator's RMSE value with the linear regression model value and to report the PLS to predict
10.	Size and Significance of Path Coefficients		All of the structural model relationships were significant H1 (PE -> FFN, $\beta = 0.518$, $p < 0.000$) H2 (SE -> FFN, $\beta = 0.679$, $p < 0.000$) The findings indicated that the Physical Environment (Public Facilities) and Social Environment (Social Capital) have a positive influence on the Family-friendly Neighbourhood (Residents' Satisfaction Level) constructs

Note: PE (Physical Environment: Public Facilities); SE (Social Environment: Social Capital); and Family-friendly Neighbourhood (Resident's' Satisfaction Level) [FFN], Adapted from Abu, F. et al. (2021)

The result of the measurement model shows that the elements of the factors is measurable as each result agreed in convergent and discriminant validity. As a result, the relationship between two factors and family-friendly neighbourhood of the study are reliable, valid, significant and supported.

- **H1**: Physical Environment (Public Facilities) [PE] has significantly positive influence on Family-friendly Neighbourhood [FFN] **(reliable, valid, significant and supported)**
- **H2**: Social Environment (Social Capital) [SE] has significantly positive influence on Family-friendly Neighbourhood [FFN] **(reliable, valid, significant and supported)**

The findings show that physical environment (public facilities) and social environment (social capital) factors were initially influencing the neighbourhood to be more family-friendly in terms of fully utilised public facilities, sufficient, good condition/quality, accessible, provided the design for people with disability (PWD)/user-friendly/child-friendly, trusted, willing to help, feel connected, get along with one another, give support, close-knit neighbourhood and share same value among families and communities.

However, based on the highest value of path coefficient (Table 5), the social environment (social capital) factor is the main factor that most positively influences the level of family-friendly neighbourhood in the study area than the physical environment (public facilities) factor. This indicates that the higher the level of social capital in the urban neighbourhood, the higher the level of family-friendliness in the study area. Hence, recognizing the importance of social capital in meeting the needs of urban families can help guide policymakers and local authorities to implement strategies that strengthen community bonds, encourage social interaction, and foster a sense of belonging. By cultivating social capital, they can create a more supportive and family-friendly environment, improving the overall well-being and happiness of urban families in the study area.

Besides, the needs of public facilities should also be provided due to these two factors are needed for the family-friendly neighbourhood. A family-friendly neighbourhood is a neighbourhood where families enjoy housing at an affordable price, good child care services, parks to play in, well-connected pedestrian pathways, quality public schools and a safe neighbourhood (Karsten, L., 2003; Israel, E. and Warner, M. E., 2008).

Therefore, towards achieving the aim of this study: assessing the relationship between physical environment (public facilities) and social environment (social capital) factors within the local community in the study area, the results from the PLS-SEM have prompted the physical environment (public facilities) and social environment (social capital) as the key factors influencing the Family-friendly Neighbourhood in the study area.

CONCLUSION

Families in urban areas require an adequate facilities, services and social interaction within their neighbours. The availability of a support system within easy reach of families is essential in their daily routine of families, without having to seek services far away. Facilities within the community offer significant support for families and “the physical place where people live is a significant dimension of community that often creates the foundation for other kinds of support and connections” (Bookman, A., 2004). It is built on the premise that policies, which make communities more family-focused, not only benefit families but also the city as a whole (Rukus, J. and Warner, M. E., 2013). In the context of Malaysia, there is currently no specific policy or framework that focuses on creating family-friendly neighbourhoods. Furthermore, the availability of literature on family-friendly neighbourhoods is limited. Recent research has tended to concentrate on the development of child-friendly cities rather than family-friendly cities. As a result, this study's review of family-friendly neighbourhood literature was restricted to publications from 2000 to 2014, which encompassed a total of 21 articles. Another challenge faced during the research was obtaining feedback from respondents during the residents' survey. Household willingness to participate and unoccupied units during data collection posed constraints, resulting in 248 household samples being collected for the study. The focus of this study is on the heads of families living in the study area. The analysis report, derived from a survey of residents using a questionnaire, reveals that the study area can be categorized into three groups: B40, M40, and T20. Since the target group encompasses all heads of families, there is no singular specific target group identified. Therefore, this study suggests a specific focus on respondents in each of the related groups, especially for the B40 group.

ACKNOWLEDGEMENTS

The authors would like to thank Universiti Teknologi MARA (UiTM) for supporting the research.

REFERENCES

Abu, F., Gholami, H., Saman, M. Z. M., Zakuan, N., Streimikiene, D. and Kyriakopoulos, G. L. (2021). An SEM Approach for the Barrier Analysis in Lean Implementation in Manufacturing Industries. Sustainability 2021. *13*, 1978.

Amin, M., Thurasamy, R., Aldakhil, A.M. and Kaswuri, A.H.B. (2016). The effect of market orientation as a mediating variable in the relationship between entrepreneurial orientation and SMEs performance. *Nankai Bus. Rev. Int. 7*, 39–59.

Becker, J.-M., Klein, K. and Wetzels, M. (2012). Hierarchical Latent Variable Models in PLS-SEM: Guidelines for Using Reflective-Formative Type Models. *Long Range Plan*. *45*, 359–394.

Bookman, A. (2004). *Starting in Our Own Backyards: How Working Families can Build Community and Survive the New Economy.* New York and London: Routledge, Taylor and Francis Group.

Duarte, P. and Amaro, S. (2018). Methods for modellingreflective-formative second order constructs in PLS: An application to online travel shopping. J. *Hosp. Tour. Technol. 9*, 295–313.

Gholami, H., Rezaei, G., Saman, M.Z.M., Sharif, S. and Zakuan, N. (2016). State-of-the-art Green HRM System. J. *Clean. Prod. 124*, 142–163.

Hair, J.F., Risher, J.J., Sarstedt, M. and Ringle, C.M. (2019). When to use and how to report the results of PLS-SEM. Eur. Bus. Rev. *31*, 2–24.

Hair, J.F., Hult, T., Ringle, C.M., Sarstedt, M. (2014). *A Primer on Partial Least Squares Structural Equation Modeling*, SAGE Publications, Inc.: Thousand Oaks, CA, USA.

Hashim, S. F., Othman, R. N. R., Hashim, H. and Nasruddin, N. (2020). Family-friendly Neighborhood in the Malaysian Perspective: A Review of Literature. International Journal of Psychosocial Rehabilitation. *24*(2), 1906-1915.

Hassan, M. A. (2020). A Modified Location Housing Affordability Index of Low and Middle Income Households in Urban Areas of Malaysia. Unpublished Thesis, Univeriti Teknologi MARA, Malaysia.

Israel, E. and Warner, M. E. (2008). Planning for Family-friendly Communities. American Planning Association. APA Memo. 1-16.

Jayasingam, S., Fujiwara, Y. and Thurasamy, R. (2018). 'I am competent so I can be choosy': Choosiness and its implication on graduate employability. *Stud. High. Educ. 43*, 1119–1134.

Kashif, M., Zarkada, A. and Ramayah, T. (2018). The impact of attitude, subjective norms, and perceived behavioural control on managers' intentions to behave ethically. *Total Qual. Manag. Bus. Excell. 29*, 481–501.

Karsten, L. (2003). Family Gentrifiers: Challenging the City as a Place Simultaneously to Build a Career and to Raise Children. Urban Studies. Taylor and Francis Group. *40*(12). 2573-2584.

Karim, H. A. (2008). The Satisfaction of Residents on Community Facilities in Shah Alam, Malaysia. *Asian Social Science. 4*(11), 131-137.

National Physical Plan (2016). PLANMalaysia, Ministry of Urban Wellbeing, Housing and Local Government.

National Physical Plan (2021). PLANMalaysia, Ministry of Urban Wellbeing, Housing and Local Government.

Noor, N. M., Gandhi, A. D., Ishak, I., and Wok, S. (2012). Development of Indicators for Family Well-Being in Malaysia. *Social Indicators Research.*

Ramayah, T., Yeap, J.A.L., Ahmad, N.H., Halim, H.A. and Rahman, S.A. (2017). Testing a Confirmatory model of Facebook Usage in SmartPLS using Consistent PLS. *Int. J. Bus. Innov. 3*, 1–14.

Rezaei, G., Gholami, H., Shaharou, A.B.M., ZameriMat Saman, M., Sadeghi, L. and Zakuan, N. (2017). Shared knowledge mediated correlation between cultural excellence and organisational performance. *Total Qual. Manag. Bus. Excell. 28*, 427–458.

Rukus, J. and Warner, M. E. (2013). Crime rates and collective efficacy: The role of family friendly planning. *Cities. 31.* 37-46.

Salleh, M. Z. M. (2022). Neuro-Landscape Model: Psychological Restoration of UiTM Students (B40) via Connectedness to Nature and Pro-Environmental Behaviour. Unpublish Thesis.

Samuel, R. and Ramayah, T. (2016). Employability, Mobility and Work-Life Balance: How do they relate for MBA holders in Malaysia? *Pertanika J. Soc. Sci. Humanit. 24*, 359–374.

Scholtz, B., Mahmud, I. and Ramayah, T. (2016). Does Usability Matter? An Analysis of the Impact of Usability on Technology Acceptance in ERP Settings. *Interdiscip. J. Inf. Knowl. Manag. 11*, 309–330.

Tehseen, S., Qureshi, Z.H. and Ramayah, T. (2018). Impact of network competence on firm's performances among Chinese and Indian entrepreneurs: A multigroup analysis. *Int. J. Entrep. 22*, 1–14.

Tehseen, S., Sajilan, S., Gadar, K. and Ramayah, T. (2017). Assessing Cultural Orientation as a Reflective-Formative Second Order Construct—A Recent PLS-SEM Approach. *Rev. Integr. Bus. Econ. Res. 6*, 38–63.

Xue, Y., Liang, H. and Wu, L. (2011). Punishment, Justice, and Compliance in Mandatory IT Settings. *Inf. Syst. Res. 22*, 400–414.

Received: 24th July 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 96 – 109

URBAN DEVELOPMENT AND WASTE MANAGEMENT PLANNING IN KABUL NEW CITY, AFGHANISTAN: A CASE STUDY

Wafaurahman Wafa[1], Amir Hamzah Sharaai[2]*, Sifatullah Mukhtar[3], Kawoon Sahak[4], Fazal Rahman Afghan[5]

[1,4,5]*Faculty of Environment,*
KABUL UNIVERSITY JAMAL-MINA AFGHANISTAN
[2] *Faculty of Forestry and Environment,*
UNIVERSITI PUTRA MALAYSIA
[3] *Infrastructure Planning and Designing* Division,
DEHSABZ-BARIKAB KABUL AFGHANISTAN

Abstract

The municipal solid waste collection system and services of existing Kabul City are not acceptable socially, economically, and environmentally. This study was carried out in 2020–2021 for the Phase-1 area of Kabul New City (KNC). The study aims to analyze different MSWCSS for the KNC area and choose the best option during the planning stage. The average incremental cost for different collection systems was determined, and the results show that the total annualized cost (AN) of the proposed waste collection system (PWCS) is 855.3699 AFN/tonne, while the total operation and maintenance cost (OP) is 577.1235 AFN/tonne. The AN and OP of the stand-alone underground waste collection system (SAUWCS), tailored collection point system, traditional (prevailed) system, and alley waste collection system (AWCS) are 911.3032 AFN/tonne and 499.9017AFN/tonne, 1,681.762 AFN/tonne and 1,267.28 AFN/tonne, 308.9254 AFN/tonne and 186.3363 AFN/tonne, and 716.7706 AFN/tonne and 410.5375 AFN/tonne, respectively. The social and environmental analysis for the PWCS, SAUWCS, existing system, and AWCS obtained scores of 19, 29, -6, 17, and -5, respectively. From the cost-benefit analysis, it has been proposed that for the PWCS of low-rise residential areas, three wheelie bins of different colors will be provided to each housing unit. The total costs per tonne of solid waste for the PWCS, SAUWCS, TCPS, and traditional system are 2,832.1952, 3,638.137205, 3,888.6272, 751.45984, and 1,975.8152, respectively. For the PWCS of residential areas, chute waste collection systems are planned for high-rise apartment buildings and SAUWCSs are planned in commercial areas.

Keywords: Municipal Solid Waste Collection, Collection System and Services, Cost-Benefit Analysis, Sustainable Development

[2] Corresponding author-mail: amirsharaai@upm.edu.my

INTRODUCTION

Municipal solid waste management (MSWM) is a major concern around the world. The increasing production of municipal solid waste (MSW) is one of the most severe problems, particularly in urban areas of developing nations. The rapid growth of population, urbanization, and economic development has exacerbated its severity, making it problematic (Chuah et al., 2023). Due to the way cities in developing countries are built, how quickly they are growing, and the lack of resources to give them the infrastructure and urban services they need, trash is not picked up well enough and is often dumped in the streets, empty lots, and open dumps (Andrianisa et al., 2016).

Municipal solid waste is an environmental concern in cities; hence, local governments and private enterprises must consider safeguarding human health, the environment, and natural assets (Li et al., 2022; Mukhtar et al., 2016). Solid waste collection is an important part of the solid waste management (SWM) process, accounting for up to two-thirds of the whole budget. The major costs of MSWM systems are devoted to the collection, and its optimization leads to a considerable reduction in marginal, financial, and environmental costs (Erfani et al., 2018). The rapid growth of global population expansion and the corresponding increase in the output of municipal solid garbage have given rise to a significant concern (Labib et al., 2021). Collection expenses, on the other hand, account for 80–90% and 50–80% of MSWM budgets in low- and middle-income countries, respectively. The overall amount spent on solid waste collection, transportation, and disposal is between 60% and 80% (Sulemana et al., 2018).

However, in high-income countries, waste collection costs less than 10% of the total SWM budget, compared to 80–90% in low-income countries. Moreover, waste is still picked up more often and more efficiently in high-income countries than in low-income countries. In developing countries, around 20–50% of their available budget is for SWM. Nevertheless, 30–60% of all urban solid garbage is not collected, and less than 50% of the population is served (Srivastava et al., 2015).

According to Forouhar & Hristovski (2012), in Afghanistan, SWM is one of the least studied environmental issues in many poor nations. Afghanistan, being a low-income developing country, is similarly confronted with SWM problems. Internal wars have largely damaged the urban environment in Afghanistan. According to Khoshbeen et al. (2020), in 2018, a city of 5 million people produced 3,050 tonnes of waste with per capita generation of about 0.61 kg per day. The aim of Kabul New City (KNC) is to achieve sustainable development in the planning stage, where aerial view maps make it quite easy to analyze different MSWCSS for selecting the best option for Phase-1 and the whole KNC area.

LITERATURE REVIEW

Ullah et al. (2022) concluded that the initial step in planning an effective MSW collection system is to identify and understand the existing challenges. Recent studies highlight common obstacles faced by developing countries, such as limited financial resources, inadequate waste collection infrastructure, informal waste disposal practices, and the lack of public awareness and participation.

Additionally, the specific context of KNC presents unique challenges related to post-conflict reconstruction, rapid urbanization, and informal settlements. To overcome these challenges, researchers emphasize the need for comprehensive waste management strategies that incorporate waste reduction, reuse, recycling, and proper disposal (Mohd Kusin et al., 2019).

Efficient planning and design of MSW collection systems play a vital role in achieving effective waste management. Recent research emphasizes the importance of considering several factors including population density, waste generation rates, distance to disposal facilities, and socioeconomic characteristics of the target area (Khoshbeen et al., 2020). Advanced technologies, including geographic information systems (GIS), optimization models, and route planning algorithms, are being employed to optimize collection routes and reduce operational costs.

Engaging stakeholders and promoting community participation are essential components of successful waste management initiatives. Recent studies emphasize the need for building partnerships among government agencies, waste management companies, non-governmental organizations (NGOs), and local communities (Mushkani & Ono, 2022). By involving the public in waste management planning, decision-making processes can be more inclusive, resulting in greater acceptance and adherence to waste management practices.

Case studies from other developing countries facing similar waste management challenges provide valuable insights. However, the waste management in these cities offers lessons on effective strategies, technologies, and policies that could be relevant to the planning of KNC's MSW collection system. Additionally, Khalil et al. (2019) offer useful recommendations for recycling policies that prioritize the creation of households' intentions. These proposals include the provision of recycling facilities, the encouragement of participation through market-driven recycling programs, and the promotion of recycling awareness and education. Moreover, Aminu et al. (2022) suggested the integration of non-residents into formal garbage collection necessitates the establishment of planning and policy implementation, as well as an institutional and legal framework. This is of utmost importance in order to achieve effective service delivery and satisfaction in areas that are currently not being serviced.

RESEARCH METHODOLOGY

Study Area

Afghanistan's capital city, Kabul, is in the eastern part of the country at 34°31' N and 69°12' E, 1,800 m above sea level (Wafa et al., 2020). The KNC project is located in the northwestern part of Kabul city at 69°.36'.18'' longitude, 34°.20'42'' latitude, and an elevation of 1,847 m. The project covers an area of approximately 740 km^2. There are approximately 54 villages within the KNC boundary, some of which have been destroyed or are no longer in existence, and approximately 140,000 people live within its borders (Habibi et al., 2021).

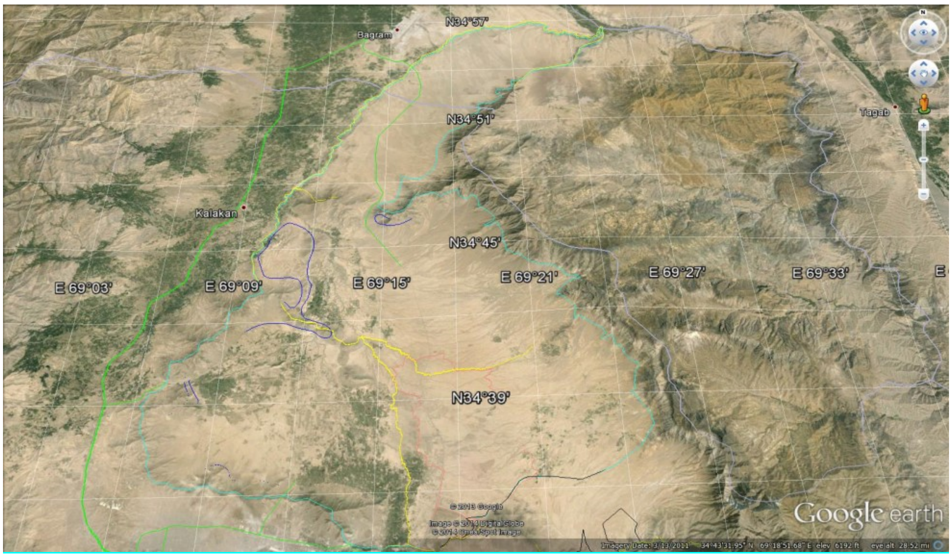


Figure 7. Figure 1: Showing the map of the whole KNC area (GIS map of Kabul New Capital)

Estimated Waste Generation Rate

Kabul's population and commercial sector are the only two major generators of MSW; the remainder comes from outside sources. the rate of solid trash production was between 0.31 kg and 0.43 kg per person per day. Meanwhile, Khoshbeen et al. (2020) stated that the amount of MSW produced in the city is predicted to increase to 3,300 tonnes per day by 2025, with a per capita production of 0.61 kg/day. A rise in garbage production per capita per day is predicted to increase by 2% on a yearly basis, which can be determined using the following formula:

$$kg/capita/day * 1 + K\%$$

For instance:

$$0.6 * 1 + \frac{2}{100} = 0.62$$

Economic and Financial Costing

Economic costing was utilized for determining the least expensive alternatives and establishing user fees for waste collection services. In order to determine the economic cost of the DCDA Phase-1 collection system, the following variables were considered:

Foreign exchange shadow factor = 1.5; opportunity cost of capita = 12%; labor cost: fringe benefits = 15%, driver pay = 12,000 AFN/month, and labor pay = 6,000 AFN/month; management and administration overhead = 10% of direct labor cost; vehicle maintenance: motorized vehicles = 20% of purchase price per year and non-motorized vehicles = 10% of purchase price per year; insurance and sundries = 5% of capital cost; economic life of vehicles = 7–15 years; economic life of container 3 and 5; and fuel cost (including tax) = 57 AFN/L.

Average Incremental Cost (AIC)

$$\frac{AIC = \sum_{t-1}^{t-T}(C_t + O_t)/(1+r)^{(t-1)}}{\sum_{t-1}^{t-T}(N_t/(1+r)^{(t-1)}}$$

Where:
t = time in years;
T = design lifetime in years (measured from the start of the project at t = 0);
C_t = construction costs incurred in year t;
O_t = incremental (from year t = 0) operation and maintenance costs incurred in year t; and
N_t = additional quantity of solid waste (from year t = 0) collected in year t.

Capital Recovery Factor (CRF)

$$\boldsymbol{CRF = \frac{r(1+r)^N}{(1+r)^{N-1}}}$$

Where:
r = interest rate; and
N = loan maturity period.

ANALYSIS AND DISCUSSION

Estimated MSW Generation of the New City

The solid waste generation in developing Asian nations ranged from 0.41 to 1.62 kg per person per day, whereas the characterized solid waste generation rate for the existing Kabul city ranged between 0. and 0.43 kg/capita/day, with approximately 70% of organic fraction including night soil with a specific weight (uncompacted waste) at the disposal site was observed (Forouhar & Hristovski, 2012).

The solid waste generation rate for Kabul City is 0.61 kg/capita/day with 52% organic fraction (Khoshbeen et al, 2020). As KNC development is in the planning stage, this characterized waste will be used for the KNC, which used 0.62 kg/capita/day starting in 2020. The annual waste in kg/capita/day of solid waste increased by 2%. As the living standard in Kabul city improves, this would increase to 0.87 kg/capita/day in 2037. Phase-1 of KNC waste generation is estimated to be 46,562 kg/day in 2020. Demographic growth is around 5%, including 3% from natural growth plus 2% from immigration (Mukhtar et al., 2016).

Table 1: Estimated waste generation

Year	Population*	Solid Waste** Generation (kg per Capita per Day)	Total Solid Waste Generation (kg per Day)	Total Solid Waste Generation (kg per Month)	Total Solid Waste Generation (kg per Year)	Biodegradable Solid Waste Generation (kg per Year) 70%	Recyclable Wholesale (kg per Year) 5%
2020	75,100	0.62	46,562	1,396,860	16,995,130	11,896,591	849,756.5
2021	112,651	0.63	71,240	2,137,215	26,002,779.73	18,201,946	1,300,139
2022	139,467	0.65	89,963	2,698,887	32,836,461.94	22,985,523	1,641,823
2023	166,283	0.66	109,406	3,282,172	39,933,090.32	27,953,163	1,996,655
2024	193,099	0.67	129,590	3,887,708	47,300,449.26	33,110,314	2,365,022
2025	219,915	0.68	150,538	4,516,153	54,946,529.32	38,462,571	2,747,326
2026	246,732	0.70	172,273	5,168,202	62,879,787.25	44,015,851	3,143,989
2027	277,366	0.71	197,536	5,926,078	72,100,616.75	50,470,432	3,605,031
2028	308,000	0.73	223,740	6,712,202	81,665,127.52	57,165,589	4,083,256
2029	338,634	0.74	250,913	7,527,401	91,583,378.47	64,108,365	4,579,169
2030	369,268	0.76	279,084	8,372,523	101,865,693.4	71,305,985	5,093,285
2031	400,000	0.77	308,357	9,250,705	1.13E+08	78,785,170	5,627,512
2032	420,000	0.79	330,250	9,907,505	120,541,309.6	84,378,917	6,027,065

Year	Population*	Solid Waste** Generation (kg per Capita per Day)	Total Solid Waste Generation (kg per Day)	Total Solid Waste Generation (kg per Month)	Total Solid Waste Generation (kg per Year)	Biodegradable Solid Waste Generation (kg per Year) 70%	Recyclable Wholesale (kg per Year) 5%
2033	441,000	0.80	353,698	10,610,938	129,099,742.6	90,369,820	6,454,987
2034	463,050	0.82	378,810	11,364,314	138,265,824.3	96,786,077	6,913,291
2035	486,203	0.83	405,706	12,171,181	148,082,697.8	103,657,888	7,404,135
2036	510,513	0.85	434,511	13,035,334	158,596,569.4	111,017,599	7,929,828
2037	**536,038**	**0.87**	**465,361**	**13,960,843**	**169,856,925.8**	**118,899,848**	**8492846**

Source: KNC Data and Author's Calculation

The population increase was assumed to be 5%*; the solid waste in kg/ capita/day was assumed to increase by 2%**.

Municipal solid waste collection in the Existing Kabul City

Garbage collection in the existing Kabul city was carried out by container collection services and door-to-door collection services Table 2.

CP Container Collection Services

In the existing Kabul city, there are approximately 4,273 collection containers, with 857 of 7 m^3 bins, 1,116 of 1 m^3 bins, and the remaining 2,300 are 0.1 m^3 bins (Khoshbeen et al., 2020). This covers an area of about 375 km^2, covering 18 cities out of a total of 22 districts. Residents bring their waste to a CP container located close to their houses. Waste spreading near the road attracts scavengers (human beings and animals). It is a deteriorating environment, which makes it unaesthetic and produces bad smells and also occupational and health problems. In Kabul city, much workforce is used to collect solid waste. According to an official of DoS, out of 3,752 DoS staff members, about 2,415 provide waste collection services, while around 1,301 are assigned to sweep the streets (Azimi et al., 2020).

Door-to-Door (D2D) System

In Kabul city, a D2D collection system has also been established in some residential areas for waste collection using compactor trucks and dump trucks. In general, there are three possibilities for collecting household garbage: municipalities collect refuse from residences using municipal employees and equipment, municipalities partner with private trash haulers to provide domestic refuse collection services, and individual homes contract with private garbage haulers for domestic refuse collection without intervention from the municipality.

Types of Buildings and Residential and Commercial Areas in Phase-1 of KNC

The KNC area is to be divided into three phases and one agriculture economic zone (a total of four phases) until 2025, but the implementation has not been carried out to date. Phase-1 and Phase-2 development plan has been accomplished. For Phase-1 and Phase-2, the area is divided into residential areas, commercial areas, industrial parks, and greenery parks. The collection of MSW from residential and commercial areas of Phase-1 is discussed in this paper. The residential and commercial areas are:

Residential Areas in Phase-1

The residential areas in phase-1 are planned to have social housing; affordable housing; high-, medium-, and low-density housing, and villas, with the plot size of 10 × 15, 10 × 20, 12 × 25, 15 × 30, 17 × 30, and 20 × 40 m^2, respectively. The accommodation of 6–9 people with a minimum of three and a maximum of four stories is shown in Table 1.

Commercial Areas in Phase-1

For Phase-1, the commercial areas are divided into mixed residential, local commercial, district commercial, and central commercial areas, with areas of 250, 200, 150, and 110 m^2, respectively, and the area of local commercial is 60 m^2. The district commercial area covers a total of 115,000 m^2 in Phase-1, while the central commercial area is about 47,600 m^2. The local commercial area has a minimum of three and a maximum of five stories, whereas the central commercial area has a maximum of ten stories.

Proposed Collection System for Phase-1 Area

Developing countries spent 20–40% of municipal revenues on solid waste collection. Out of the total money spent on SWM, 60–80% is spent on the collection of solid waste (Bhargava et al., 2019). Improvement of collection operation by a small percentage can give significant savings in the overall cost. The collection system for the Phase-1 area is proposed as follows:

Solid Waste Collection for Residential Areas

A 2,410 m^2 area is allocated for the residential houses in the Phase-1 of KNC. Three different colored wheelie bins will be used by each house for onsite segregation and the collection of waste in each residential house. The waste from these wheelie bins will be collected door to door. It will be transported to the transfer station that has been planned in Phase-1. The KNC area will have recycling industries. The feedstock of these recycling industries will be taken from the KNC area. Onsite segregation will be carried out by the residents. Different studies show that the segregation of these wastes by NGOs or private entities gives great benefits. Also, local people will improve the habits of source segregation. In 7 years, the privatization of solid waste collection activities has improved from 10% to 40%. For attaining sustainability in waste management, this approach by NGOs or private entities is considered to be the right measure (Kassim & Ali, 2006). A 1-year survey of 126 municipalities indicated that contracting solid waste collection services saved a significant amount of money (McDavid, 1985). Therefore, the Phase-1 area of KNC will be given either the recyclables or other waste collection by the NGOs, CBOs, etc. or it will be given to the municipality, and it will be decided later in the operation and maintenance of the area. A compactor truck will be used for the collection of this garbage.

Solid Waste Collection for Commercial Areas

However, securing the investment cost for a pneumatic waste collection system is hard for developing countries, and the maintenance procedure is also complicated. A pneumatic waste collection system provides the best environmental performance. From another point of view, pneumatic waste collection methods are better than traditional ones because they make less noise, cause less accidents, smell less, and cause less traffic jams. Nonetheless, under an existing metropolitan infrastructure, the total air emissions would increase (Vásquez et al., 2013). A special compactor truck will be used for the collection of garbage from the commercial areas.

High-Rise Apartment Buildings

Most high-rise apartment buildings with more than seven floors have a chute collection system. The same approach will be used for KNC. For the efficiency of the collection system for high-rise apartment buildings, the chute collection system will be used for the Phase-1 area. It has been planned in this stage that the chute system could be used for apartment buildings with more than seven floors. A compactor truck will be used for the collection of garbage.

Transfer Station

One transfer station has been selected for the Phase-1 area with a land size of approximately 2 hectares. The transfer station and its routing for the collection of solid waste have not been considered because the tertiary roads have not been finalized yet. For transportation, the distance taken into consideration is 149.6 km of the total Phase-1 roads (primary and secondary). In more detail, the complete solid waste collection system will be prepared with a more realistic approach after the complete routing of collection services. More detailed routing of the collection system will be carried out using GIS/CAD software.

Table 2: Showing cost of different waste collection system in AFN

	Proposed waste collection system		**Stand Alone Underground Waste Collection system**		**Tailored System Proposed by JICA study team**			**Traditional Used as a Restrain or Control system.**		**Alley Container Collection services**	
Capital	**Vehicles**	**Container**	**Vehicles**	**Container**	**Vehicles**	**Container**	**Civil work**	**Vehicles**	**Container**	**Vehicles**	**Container**
Purchase price per unit	2280000	5070	4000000	441752	2280000	19950	5000	23960	19950	1140000	28500
Total Purchase unit	44	2254	**15**	221	100	1391	464	113	1391	63	125
Estimated life (years)	15	5	15	15	15	3	20	7	3	7	3
Foreign Exchange shadow factor	1.5	1.5	1.5	1.5	1.5	1.5	0	1.5	1.5	1.5	1.5
Shadow system Purchase	150480000	17140158	90000000	146,470,253	342247541	41631302	2318646.729	4061220	41631302.02	106952356.6	5347618
Total shadowed system vehicles + container	**167620158**		**236,470,253**		**386197490**			**45692522**		**112299974**	
Operation and Maintenance											
Driver	528000		180000		1200869			1356000		750543	
Unskilled Laborer	264000		90000		600434			678000		375271	
Shadowed unskilled labor shadow factor	1		1		1			1		1	
Shadowed unskilled labor cost	264000		90000		600434			678000		375271	
Total shadowed system labor cost	**792000**		**270000**		**1801303**			**2034000**		**1125814**	
Fuel in Afghani/ liter for the tripping in whole phase-1 area with tax	921063		251199		1674660			1892366		1055036	
Total	**921063**		**251199**		**1674660**			**1892366**		**1055036**	
Vehicles Maintenance	30096000	1714016	18000000	14,647,025	68449508	4163130	231865	812244	4163130	21390471.31	534762
Total Maintenance cost	**31810016**		**32,647,025**		**72844503**			**4975374**		**21925233**	

Management and administration overheads (10 % of direct labor cost)	7920 0	251 20	180 130	203 400	1125 81
Total System management	7920 0	251 20	180 130	203 400	1125 81
Insurance and sundries (5% of capital cost)	**7524 000**	**4,50 0,00 0**	**171 123 77**	**203 061**	**5347 618**
Total system Operation and Maintenance cost	**41047079**	**37,668,224.28**	**93432843**	**9104801**	**29453701**
Waste collection					
Trip per day	2	2	2	2	2
Tons per trip	101	103 s	101	100	98
Tons per year 365 working days	73677	75351	73677	72921	71744

Source: Kabul city Municipality

CONCLUSION

The development of a comprehensive and efficient MSW collection system is crucial for the sustainable development of KNC in Afghanistan. This research focused on planning an effective MSW collection system and services in KNC by considering the problems of waste management in emerging countries. The study emphasized the importance of understanding the challenges, such as limited financial resources, inadequate infrastructure, informal waste disposal practices, and lack of public awareness and participation.

The research aimed to propose a waste collection system that addresses the specific needs of KNC and promotes sustainable development. Various approaches were employed, including estimating waste generation rates, conducting economic and financial costing, and utilizing cost-benefit analysis. These methods provided insights into waste generation levels, costs associated with waste collection, and potential benefits of different collection system options. Based on the findings, suggestions were made on how the MSW collection system in KNC should be set up. These include implementing door-to-door collection for residential areas, a stand-alone underground system for commercial areas, and a chute collection system for high-rise buildings. Factors such as population density and waste generation rates were considered in determining the appropriate system for each area. The research emphasized the importance of stakeholder engagement and community participation in waste management initiatives. Building partnerships among government agencies, waste management companies, NGOs, and local communities is essential for inclusive decision-making and successful implementation of waste management practices.

The proposed waste collection system offers a promising approach to address waste management challenges in KNC. By optimizing collection routes, reducing costs, and promoting waste reduction and resource recovery, the system can contribute to environmental sustainability and public health in KNC. However, implementing the proposed system will require careful planning, investment, and ongoing monitoring and evaluation. Collaboration, adequate funding, and continuous education and awareness programs are necessary for the long-term success and sustainability of the MSW collection system in KNC. Overall, this research provides valuable insights and recommendations for the planning and development of an effective MSW collection system in KNC, Afghanistan. By addressing specific challenges and considering sustainable waste management practices, KNC can work toward a cleaner, healthier, and more environmentally friendly future.

REFERENCES

Aminu, M., Abd Manaf, L., Sharaai, A. H., & Zainordin, N. S. (2022). Solid Waste Collection Service Satisfaction in Non-Service Area of Jigawa State, Nigeria. *Journal of Environmental Management & Tourism*, *13*(5), 1407–1415.

Andrianisa, H. A., Brou, Y. O. K., & Séhi bi, A. (2016). Role and importance of informal collectors in the municipal waste pre-collection system in Abidjan, Côte d'Ivoire. *Habitat International*, *53*, 265–273. https://doi.org/10.1016/j.habitatint.2015.11.036

Azimi, A. N., Dente, S. M. R., & Hashimoto, S. (2020). Analyzing Waste Management System Alternatives for Kabul City, Afghanistan: Considering Social, Environmental, and Economic Aspects. *Sustainability*, *12*(23), 9872.

Bhargava, K., Gupta, R., Singhal, A., & Shrinivas, A. (2019). Genetic Algorithm to Optimize Solid Waste Collection. *Proceedings of the 3rd International Conference of Recent Trends in Environmental Science and Engineering (RTESE'19)*, 1–8. https://doi.org/10.11159/rtese19.110

Chuah, S.-C., Putit, L., & Singh, J. S. K. (2023). ASSESSING RESIDENTS' INTENTION TOWARDS MUNICIPAL SOLID WASTE SOURCE SEPARATION: A CASE STUDY OF MALAYSIA. *PLANNING MALAYSIA*, *21*(25 SE-Article). https://doi.org/10.21837/pm.v21i25.1245

Erfani, S. M. H., Danesh, S., Karrabi, S. M., Shad, R., & Nemati, S. (2018). Using applied operations research and geographical information systems to evaluate effective factors in storage service of municipal solid waste management systems. *Waste Management*, *79*, 346–355.

Forouhar, A., & Hristovski, K. D. (2012). Characterization of the municipal solid waste stream in Kabul, Afghanistan. *Habitat International*, *36*(3), 406–413. https://doi.org/10.1016/J.HABITATINT.2011.12.024

Habibi, S. M., Ono, H., & Shukla, A. (2021). Geographical Information System (GIS) Based Multi-Criteria Decision Analysis for Categorization of the Villages: In the Case of Kabul New City Villages. *Urban Science*, *5*(3), 65.

https://doi.org/10.3390/urbansci5030065

Kassim, S. M., & Ali, M. (2006). Solid waste collection by the private sector: Households' perspective—Findings from a study in Dar es Salaam city, Tanzania. *Habitat International*, *30*(4), 769–780. https://doi.org/10.1016/j.habitatint.2005.09.003

Khalil, M. S., Ming, H. Y., Abd Manaf, L., Sharaai, A. H., & Nabegu, A. B. (2019). INCOME PERSPECTIVE ON THE FACTORS INFLUENCING HOUSEHOLDS' RECYCLING INTENTION: IMPLICATIONS FROM THE EXTENDED THEORY OF PLANNED BEHAVIOUR. *PLANNING MALAYSIA*, *17*(10 SE-Article). https://doi.org/10.21837/pm.v17i10.640

Khoshbeen, A. R., Logan, M., & Visvanathan, C. (2020). Integrated solid-waste management for Kabul city, Afghanistan. *Journal of Material Cycles and Waste Management*, *22*(1), 240–253. https://doi.org/10.1007/s10163-019-00936-z

Labib, O. A., Manaf, L., Sharaai, A. H., & Zaid, S. S. (2021). Understanding the Effect of Internal and External Factors on Households' Willingness to Sort Waste in Dammam City, Saudi Arabia. In *International Journal of Environmental Research and Public Health* (Vol. 18, Issue 18). https://doi.org/10.3390/ijerph18189685

Li, Y., Sharaai, A. H., Ma, S., Wafa, W., He, Z., & Ghani, L. A. (2022). Quantification of Carbon Emission and Solid Waste from Pottery Production by Using Life-Cycle Assessment (LCA) Method in Yunnan, China. In *Processes* (Vol. 10, Issue 5). https://doi.org/10.3390/pr10050926

McDavid, J. C. (1985). The Canadian experience with privatizing residential solid waste collection services. *Public Administration Review*, *45*(5), 602–608. https://doi.org/10.2307/3109936

Mohd Kusin, F., Md Joni, A. A., Mohamat Yusuff, F., & Syed Hasan, S. N. M. (2019). EVALUATING CAPACITY BUILDING OF THE LOCAL COMMUNITY TOWARDS ENVIRONMENTAL CONSERVATION IN AN ESTUARINE COMMUNITY, KONG KONG LAUT, JOHOR. *PLANNING MALAYSIA*, *17*(10 SE-Article). https://doi.org/10.21837/pm.v17i10.632

Mukhtar, S., Wafa, W., Halimzai, H., & Shams, A. K. (2016). Planning for the Solid Waste Management of Central Park in New Capital Development of Afghanistan. *Journal of Environmental Protection*, *7*(06), 805–815. https://doi.org/10.4236/jep.2016.76073

Mushkani, R. A., & Ono, H. (2022). Urban planning, political system, and public participation in a century of urbanization: Kabul, Afghanistan. *Cogent Social Sciences*, *8*(1), 2045452.

Srivastava, V., Ismail, S. A., Singh, P., & Singh, R. P. (2015). Urban solid waste management in the developing world with emphasis on India: challenges and opportunities. *Reviews in Environmental Science and Bio/Technology*, *14*, 317–337.

Sulemana, A., Donkor, E. A., Forkuo, E. K., & Oduro-Kwarteng, S. (2018). Optimal routing of solid waste collection trucks: A review of methods. *Journal of Engineering*, *2018*.

Ullah, S., Bibi, S. D., Ali, S., Noman, M., Rukh, G., Nafees, M. A., Bibi, H., QIAO, X. C., Khan, S., & Hamidova, E. (2022). ANALYSIS OF MUNICIPAL SOLID WASTE MANAGEMENT IN AFGHANISTAN, CURRENT AND FUTURE

PROSPECTS: A CASE STUDY OF KABUL CITY. *Applied Ecology & Environmental Research*, *20*(3).

Vásquez, D. Z., Usón, A. A., Zabalza, I., Bribián, I. Z., & Ferreira, G. (2013). Environmental Performance of Applying Alternative Energies to the Collection, Transport and MBT Plant Within an Integrated MSW Management System. In *Alternative Energies* (pp. 267–287). Springer. https://doi.org/10.1007/978-3-642-40680-5

Wafa, W., Hairan, M. H., & Waizy, H. (2020). The Impacts of Urbanization on Kabul City ' s Groundwater Quality. *International Journal of Advanced Science and Technology*, *29*(4), 10796–10809. http://sersc.org/journals/index.php/IJAST/article/view/33587

Received: 26th June 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 110 – 125

SELECTING A STANDARD SET OF ATTRIBUTES FOR THE DEVELOPMENT OF MACHINE LEARNING MODELS OF BUILDING PROJECT COST ESTIMATION

Hafez Salleh[1], Rui Wang[2], Nur Zahirah Haji Affandi[3], Zulkiflee Abdul-Samad[4]

[1,2,3,4] Centre of Building Construction and Tropical Architecture (BuCTA), Faculty of Built Environment,
UNIVERSITI MALAYA

Abstract

Accurate cost estimation is a critical aspect of successful construction projects, and the application of machine learning offers promising advancements in this domain. However, to achieve reliable cost predictions, the selection of a standardized set of attributes that significantly influence model performance is essential. This research addresses the research gap by investigating the systematic clarification of a standard set of attributes for machine learning models in building cost estimation. Firstly, plenty of attributes were summarized by literature review, then by questionnaire surveying and focus group discussion of the Delphi study period, the final 68 ranked attributes were determined and formulated the attribute set of building data. The findings of this research are beneficial to improve the accuracy of estimation by providing the essence of developing a building cost estimation of machine learning because the domain researcher can refer to these listed attributes to determine the lay structure of a new model.

***Keywords**:* Standardized set of attributes, cost estimation model, machine learning

[4] Senior Lecturer at Universiti Malaya. Email: zulkiflee1969@um.edu.my

INTRODUCTION

In the construction industry, accurate building cost estimation is essential for project success, budget planning, and resource allocation (Car-Puši & Mladen, 2020; Elmousalami, 2020). Traditional methods often rely on expert judgment and historical data, leading to time-consuming and biased estimates (Hashemi et al., 2020). The advent of machine learning offers a promising alternative, enabling data-driven approaches to improve accuracy and efficiency (Abed et al., 2022; Hashemi et al., 2020). However, there is a lack of sufficient research focusing on the selection of a standardized attribute set for machine learning models in building cost estimation (Elmousalami, 2020; Pike & Grosse, 2018). This research aims to address the gap by clarifying a standard set of attributes for the development of machine learning models in building cost estimation.

To effectively solve the above problem, this research summarized the long list of attributes of building data by literature review and used the Delphi method including questionnaire surveying and focus group discussion to rank and screen key attributes for cost estimation and further formulate a standard set of attributes for building a cost estimation model. This research holds significant implications for the construction industry and the field of machine learning applications. The establishment of a standardized attribute set will enhance transparency and comparability in cost estimation practices, empowering scholars to make informed references.

LITERATURE REVIEW

The theoretical foundation for developing a cost estimation model by machine learning

With the development of Artificial Intelligence (AI) technology, more and more innovative machine learning models were developed to improve the accuracy of building cost estimation (Elmousalami, 2020). Developing a prediction model is a common process of data mining, which involves using statistical and machine learning techniques to analyze and extract useful patterns and relationships from large datasets (Lu & Zhang, 2022), so it is essential to clarify the main procedures of data mining before developing a machine learning model. In general, the Cross-Industry Standard Process for Data Mining (CRISP-DM) model can provide effective guidance for developing data mining techniques, and it provides a systematic and comprehensive approach to developing machine learning models, making it an ideal choice for building cost estimation models that are reliable, relevant, and aligned with business objectives (Schröer et al., 2021).

As Figure 1, the CRISP-DM model is composed of six steps for data mining: business understanding, data understanding, data preparation, modelling, evaluation and development (Schröer et al., 2021). It is obvious that business understanding is the key step and also the basis of subsequent work. The critical task of business understanding for developing a cost estimation model is to identify the attributes of building data from big data, precise and vital attribute set is beneficial to construct the structure of the cost estimation model and guide the limitation of data collection and data cleaning (Elmousalami, 2020).

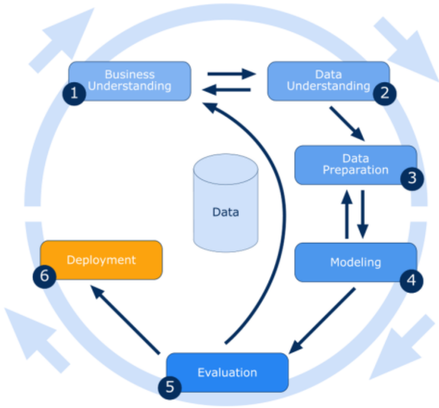


Figure 1: The Cross-Industry Standard Process for Data Mining Model (CRISP-DM)
Source: (Schröer et al., 2021; Wirth & Hipp, 2000)

Attributes of building data for cost estimation

Attributes in building cost estimation refer to the specific characteristics or factors that are considered in the estimation process to determine the cost of constructing a building or structure (Elhag & Boussabaine, 1998; Elmousalami, 2020). These attributes provide a basis for quantifying and evaluating the various elements that contribute to the overall cost.

In the context of building a cost estimation model, attributes refer to the variables or features used as input to the model to predict or estimate costs (Elmousalami, 2020). These attributes capture relevant information about the projects, activities, or resources that influence the cost. The quality and relevance of the attributes significantly impact the accuracy and effectiveness of the cost estimation model (Pike & Grosse, 2018).

The following table shows the collected attributes derived for building Cost estimation from various literature reviews. It also shows the cost-estimating techniques that were adopted for Estimating the cost of the building. There are 11 categories to group the attributes and the categories are Project Strategic, Parties-involved, Site-related, Mechanical and Electrical, Building-component, Design-related, Material-related, Area-related, Ratio-related, Households-related and External Influences.

Table 1: Categorization of attributes of building datasets

No.	Attributes	Citations
Project Strategic Variables (V1)		
1	Bidding environment	(Chan & Park, 2005)
2	Duration	(Jumas et al., 2018), (Ahiaga-Dagbui & Smith, 2014), (Bala et al., 2014), (S. Kim & Shim, 2014), (Elfaki et al., 2014), (Emsley et al., 2002), (G.-H. Kim et al., 2004), (Elhag & Boussabaine, 1998)
3	Estimating Method	(Alshemosi & Alsaad, 2017), (Al-Khaldi, 1990)
4	Importance for the project to be completed within budget	(Chan & Park, 2005)
5	Procurement Strategy	(Emsley et al., 2002)
6	Project Type	(Ahiaga-Dagbui & Smith, 2014), (Elhag & Boussabaine, 1998)
7	Quality of Building	(Emsley et al., 2002)
8	Quality of Project Information	(Riquelme & Serpell, 2013)
9	Tendering Strategy	(Ahiaga-Dagbui & Smith, 2014), (Elfaki et al., 2014), (Emsley et al., 2002)
10	Contract Form/ Type of Contract	(Chan & Park, 2005), (Emsley et al., 2002), (Elhag & Boussabaine, 1998)
11	Purpose/ Type of use	(Jumas et al., 2018), (El-Sawalhi & Shehatto, 2014), (S. Kim & Shim, 2014), (Chan & Park, 2005), (Emsley et al., 2002)
12	Year (Built year)	(S. Kim & Shim, 2014), (G.-H. Kim et al., 2004)
Parties-involved Variables (V2)		
2.1 Consultant		
13	Experience with similar projects	(Chan & Park, 2005)
14	Level of construction sophistication	(Chan & Park, 2005)
15	staffing level to attend to the contractor	(Chan & Park, 2005)
16	No. of DBB/DB projects handled by the consultant in the past	(Chan & Park, 2005)
2.2 Contractor		
17	Financial Management ability	(Chan & Park, 2005)
18	Design capability	(Chan & Park, 2005)
19	Experience with similar size of projects	(Chan & Park, 2005)
20	Experience with similar types of projects	(Chan & Park, 2005)
21	Health and safety management capability	(Chan & Park, 2005)
22	Key personnel's management ability	(Chan & Park, 2005)
23	Prior working relationship with consultants and owner	(Chan & Park, 2005)
24	Quality control and management capability	(Chan & Park, 2005)
25	Staffing level	(Chan & Park, 2005)
26	Technical expertise	(Chan & Park, 2005)
27	Track record for completion on budget, time and acceptable quality	(Chan & Park, 2005)
28	Level of Technologically Advancement	(Chan & Park, 2005)
29	Size of the contractor by paid-up capital (US$)	(Chan & Park, 2005)
30	The magnitude of claims and disputes in contractor's past projects	(Chan & Park, 2005)
31	Adequacy of contractor's plant and equipment	(Chan & Park, 2005)
2.3 Client related		
32	No. of DBB/DB projects handled by owner in the past	(Chan & Park, 2005)
33	Owner's experience with similar projects	(Chan & Park, 2005)

No.	Attributes	Citations
34	Owner’s level of construction sophistication	(Chan & Park, 2005)
35	Owner’s staffing level to attend to the contractor	(Chan & Park, 2005)
Site-related variables (V3)		
36	Geology property (Soft, Medium, Hard)	(M.-Y. Cheng & Wu, 2005)
37	Location (Including location index)	(Ahiaga-Dagbui & Smith, 2014), (Alshemosi & Alsaad, 2017), (S. Kim & Shim, 2014), (Al-Khaldi, 1990), (An et al., 2007)
38	Location of the core (e.g., central, peripheral)	(Doğan et al., 2006), (Doğan et al., 2008)
39	Seismic Zone	(J. C. P. Cheng et al., 2010)
40	Site Access	(Ahiaga-Dagbui & Smith, 2014), (Bhokha & Ogunlana, 1999), (Emsley et al., 2002), (Elhag & Boussabaine, 1998)
41	Site Condition (Including ground condition)	(Alshemosi & Alsaad, 2017), (J. C. P. Cheng et al., 2010), (Al-Khaldi, 1990), (Riquelme & Serpell, 2013), (Elhag & Boussabaine, 1998)
42	Soil Type	(Ahiaga-Dagbui & Smith, 2014)
43	Topography	(Emsley et al., 2002)
44	Type of Location	(Emsley et al., 2002)
45	Type of Site	(Emsley et al., 2002)
Mechanical and Electrical related variables (V4)		
46	Air conditioning system	(Emsley et al., 2002)
47	Electrical buried pipe	(Jiang, 2019)
48	Electrical installations	(Emsley et al., 2002)
49	Electro-mechanical infrastructure	(J. C. P. Cheng et al., 2010)
50	Mechanical Installations	(Emsley et al., 2002)
51	**No. of elevators	(Ji et al., 2011), (Ahn et al., 2014), (El-Sawalhi & Shehatto, 2014), (Ji et al., 2019), (Emsley et al., 2002)
52	Protective Installation (fire protection)	(Emsley et al., 2002)
53	Special Installations	(Emsley et al., 2002)
54	Type of Mechanical works	(El-Sawalhi & Shehatto, 2014)
55	Type of electricity works	(El-Sawalhi & Shehatto, 2014)
Building-component variables (V5)		
5.1 Structural		
56	Type of foundation	(Jumas et al., 2018), (Arafa & Alqedra, 2011), (El-Sawalhi & Shehatto, 2014), (Doğan et al., 2006), (Hong et al., 2011), (Doğan et al., 2008), (Latief et al., 2013), (An et al., 2007), (Bhokha & Ogunlana, 1999) , (Feng & Li, 2013), (Ahn et al., 2014)
57	Building envelope	(Emsley et al., 2002)
58	Structural units	(Emsley et al., 2002)
59	Structure form	(Feng & Li, 2013)
60	Structure type	(Ji et al., 2011), (Hong et al., 2011)
61	Substructure	(S. Kim & Shim, 2014) , (Emsley et al., 2002)
62	Superstructure	(S. Kim & Shim, 2014)
63	Retaining Wall	(S. Kim & Shim, 2014)
64	Type of Slab	(El-Sawalhi & Shehatto, 2014)
65	Usage of basement	(An et al., 2007), (G.-H. Kim et al., 2004)
5.2 Architectural		
66	Windows and doors	(Feng & Li, 2013), (Emsley et al., 2002)
67	Wall (Internal and External)	(S. Kim & Shim, 2014), (Emsley et al., 2002)
68	Ceiling	(S. Kim & Shim, 2014)
69	Floor Type	(Doğan et al., 2006), (Doğan et al., 2008)

No.	Attributes	Citations
70	Roof (construction, & profile)	(Emsley et al., 2002)
71	Type of roof	(Jumas et al., 2018) , (Ji et al., 2011), (Ahn et al., 2014), (S. Kim & Shim, 2014), (An et al., 2007), (G.-H. Kim et al., 2004)
72	Type of Tiling	(El-Sawalhi & Shehatto, 2014)
5.3 Finishes		
73	Ceiling Finishes	(Emsley et al., 2002)
74	Floor Finishes	(Emsley et al., 2002)
75	Wall Finishes	(Emsley et al., 2002)
76	Roof Finishes	(Emsley et al., 2002)
Design-related variable (V6)		
77	Building height	(Jumas et al., 2018) , (Alshemosi & Alsaad, 2017) , (Bala et al., 2014), (Jin et al., 2012), (Bhokha & Ogunlana, 1999), (Emsley et al., 2002)
78	Level of Design Complexity	(Chan & Park, 2005)
79	No. of buildings	(Hong et al., 2011)
80	No. of floors	(Ji et al., 2011), (Ahn et al., 2014), (Arafa & Alqedra, 2011), (Bala et al., 2014), (S. Kim & Shim, 2014), (Jin et al., 2012), (Ji et al., 2019), (J. C. P. Cheng et al., 2010), (Doğan et al., 2006), (Doğan et al., 2008), (Feng & Li, 2013), (Sonmez, 2004)
81	No. of units	(Jiang, 2019), (An et al., 2007), (G.-H. Kim et al., 2004)
82	No. of similarly constructed buildings	(Hong et al., 2011)
83	Shape Complexity	(Emsley et al., 2002)
84	Type of Ground Plan (e.g., open space/ compartmentalised)	(Hong et al., 2011)
Material-related variables (V7)		
85	Concrete	(Jiang, 2019)
86	Masonry	(Jiang, 2019)
87	Steel bar	(Jiang, 2019)
Area-related variables (V8)		
88	External Wall area	(Jumas et al., 2018), (Bala et al., 2014)
89	Area per unit	(Latief et al., 2013), (Sonmez, 2004), (Ji et al., 2019), (An et al., 2007)
90	Building Area	(Amin, 2017), (Sonmez, 2004), (Shin, 2015)
91	Compactness (external wall area/ gross external floor area)	(Jumas et al., 2018), (Bala et al., 2014)
92	Gross External Floor Area	(Bala et al., 2014)
93	Gross Floor Area	(Jumas et al., 2018), (Ji et al., 2011), (Ahn et al., 2014), (Latief et al., 2013), (An et al., 2007), (Hong et al., 2011), (Shin, 2015), (G.-H. Kim et al., 2004), (Elhag & Boussabaine, 1998)
94	Functional Area	(Bhokha & Ogunlana, 1999)
95	The gross floor area of the subsidiary facilities	(Hong et al., 2011)
96	Ground Area	(Jin et al., 2012)
97	Ground Floor Area	(Arafa & Alqedra, 2011)
98	Land Area	(Amin, 2017)
99	Landscape Area	(Jin et al., 2012), (Hong et al., 2011)
100	Site area	(Jin et al., 2012), (J. C. P. Cheng et al., 2010), (Hong et al., 2011)
101	Structural Parking Area	(Arafa & Alqedra, 2011), (Sonmez, 2004)
102	Total area	(Alshemosi & Alsaad, 2017), (S. Kim & Shim, 2014), (Doğan et al., 2006), (Doğan et al., 2008)
103	Typical Floor Area	(Arafa & Alqedra, 2011), (El-Sawalhi & Shehatto, 2014)

No.	Attributes	Citations
104	*Underground area	(Jin et al., 2012), (Hong et al., 2011)
105	Lot area	(Ahn et al., 2014)
Ratio-related variables (V9)		
106	*Floor Area ratio	(S. Kim & Shim, 2014), (Jin et al., 2012)
107	*Building Coverage ratio	(S. Kim & Shim, 2014), (Jin et al., 2012)
108	Building ratio	(Hong et al., 2011)
109	Building to-plan ratio	(Hong et al., 2011)
110	Number of Units per Number of Storeys Ratio	(Latief et al., 2013)
111	The ratio of floor area to total area	(Doğan et al., 2006), (Doğan et al., 2008)
112	The ratio of the footprint area to the total area	(Doğan et al., 2006), (Doğan et al., 2008)
113	The ratio of typical floor area to GFA	(Jumas et al., 2018)
114	Wall-to-floor ratio	(Emsley et al., 2002)
Households-related variables (V10)		
115	No. of households	(Ji et al., 2011), (Hong et al., 2011), (Ahn et al., 2014), (Arafa & Alqedra, 2011), (J. C. P. Cheng et al., 2010)
116	No. of households per piloti	(Ji et al., 2011), (Ahn et al., 2014)
117	No. of households per unit floor	(Ji et al., 2011), (Ahn et al., 2014)
118	No. of households per building	(Ji et al., 2011), (Ahn et al., 2014)
119	Type of household	(Hong et al., 2011)
External Influences variables (V11)		
120	Earthquake impact (Low, High)	(M.-Y. Cheng & Wu, 2005)
121	Economic Instability	(Alshemosi & Alsaad, 2017), (Al-Khaldi, 1990)
122	Weather Conditions	(Riquelme & Serpell, 2013)
123	Market Status	(Alshemosi & Alsaad, 2017), (Elhag & Boussabaine, 1998)

RESEARCH METHODOLOGY

The application of the Delphi study in this research is to poll a group of experts to reach a group consensus regarding the attributes of Big Data Analytics in building cost estimation. The Delphi study was conducted in June 2023 in the Faculty of Built Environment, University of Malaya and mainly includes two rounds: ranking the different attributes from the literature review by questionnaire; validating the result of the attribute set of the building by focus group discussion. The 14 experts of the Delphi study are shown in Table 2.

Table 2: Expert panel list of the Delphi method

Experts	Age	Gender	Position	Working Experience
A1	33	Male	Construction data technical staff	7 years (Enterprise)
A2	41	Female	Construction data technical staff	16 years (Enterprise)
A3	32	Male	Construction data technical staff	5 years (Enterprise)
A4	38	Male	Academia in quantity surveying	8 years (Institute)
A5	31	Female	Academia in quantity surveying	7 years (Institute)
A6	42	Male	Academia in quantity surveying	8 years (Institute)
A7	36	Female	Academia in quantity surveying	5 years (Institute)
A8	35	Female	Academia in quantity surveying	4 years (Institute)
A9	44	Male	Manager of Building Cost Services	8 years (Enterprise)

Experts	Age	Gender	Position	Working Experience
A10	51	Male	Manager of Building Cost Services	12 years (Enterprise)
A11	38	Female	Manager of Building Cost Services	7 years (Enterprise)
A12	36	Female	Cost engineer	5 years (Enterprise)
A13	47	Male	Cost engineer	12 years (Enterprise)
A14	44	Male	Cost engineer	8 years (Enterprise)

Round 1: Ranking the different attributes

The first round of the Delphi Study is conducted using Questionnaire Survey, selected panel experts will be asked to evaluate the attributes compiled from the literature review according to the suitability of the attributes to be used for building cost estimation. The Likert scale in the first round of the Delphi Study ranges from Unsuitable to Highly Suitable as shown in Table 3. Subsequently, the data from the questionnaire will be regularised and averages calculated to determine the suitability of the attributes for use in construction cost estimation.

Table 3: Likert Scale used in the First Round of the Delphi Study

Score	1	2	3	4	5
Measure	Not Suitable	Less Suitable	Moderately Suitable	Fairly Suitable	Highly Suitable

Round 2: Validating the result of the attribute set of the building

In round 2 of the Delphi Study Method, the validation of the attributes is made through focus group sessions. A focus group is also known as a group interview which is moderated and the outcome of this interview will be studied. Participants commented on the results of the attribute set of building obtained in the previous round based on their own research and work experience and ultimately voted to approve or disapprove of the output finding after deliberation.

RESULT AND DISCUSSION

Ranked attributes according to the suitability

From the data collection and data analysis, the attributes have been ranked according to the panel experts' votes using the Likert scale. The score for each attribute is obtained by averaging the scores of the 14 experts. According to the ranked version of the attributes, this research concluded that the highest-ranking attributes are in the categories of Project Strategic, Design Strategic, Area Related and Ratio related. Whereas some of the lowest ranked attributes are in the categories of Household related and Parties Involved. Table 4 lists the attributes with mean points of more than 4.500 and subsequently voted as the most suitable sets of attributes.

Table 4: Attributes with the Highest Ranking

No.	Attributes	Categories	Mean
1	Duration	V1	**4.833**
2	Quality of Project Information	V1	
3	Design Complexity	V6	
4	Type of Ground Plan (e.g., open space/ compartmentalised)	V6	
5	Concrete	V7	
6	Gross Floor Area	V8	
7	Wall to Floor Ratio	V9	
8	Building to Plan Ratio	V9	
9	Total Area	V8	**4.667**
10	Typical Floor Area to GFA Area ratio	V9	
11	Footprint Area to Total Area ratio	V9	
12	Floor Area to Total Area ratio	V9	
13	Floor Area Ratio	V9	
14	Functional Area	V8	
15	Area Per Unit	V8	
16	Number of Similar Constructed Buildings	V6	
17	Estimating Method	V1	
18	Tendering Strategy	V1	**4.500**
19	Consultant Level of Construction Sophistication	V2	
20	Contractor Financial Management	V2	
21	Contractor Experience with similar project	V2	
22	Contractor Key's Personnel Management Ability	V2	
23	Site Condition (including ground condition)	V3	
24	Location (including location index)	V3	
25	Gross External Floor Area	V8	
26	Lot Area	V8	
27	Soil Type	V3	
28	Steel Bar	V7	
29	Market Status	V11	
30	Economic Instability	V11	
31	Weather condition	V11	
32	Location of the core (e.g., central, peripheral)	V3	
33	Ground Floor Area	V8	
34	Ground Area	V8	
35	Number of Units	V6	
36	Number of floors	V6	
37	Height	V6	
38	Roof Finishes	V5	
39	Wall Finishes	V5	
40	Floor Finishes	V5	
41	Ceiling Finishes	V5	

No.	Attributes	Categories	Mean
42	Type of Tiling	V5	
43	Floor Type	V5	
44	Ceiling Finishes	V5	
45	Walls Finishes	V5	

Therefore, the attributes listed in Table 4, should be taken into account when developing a building cost estimation model. However, the specific rank of each attribute may depend on the purpose and objective of the constructed building. Each building project has unique elements and characteristics to it. Meanwhile, the procedure of selecting the right attributes, whereby the scope of the project must be determined first.

Validated attribute set of building

Round 2 of the Delphi study first invited 14 experts to comment on the result of the ranking evaluation, together voting on whether the attribute list is sufficient and precise. According to the Pie Chart in Figure 2, 10 out of 14 agreed on the listed attributes and categorized attributes. However, 4 out of 10 suggest an improvisation to the listed attributes.

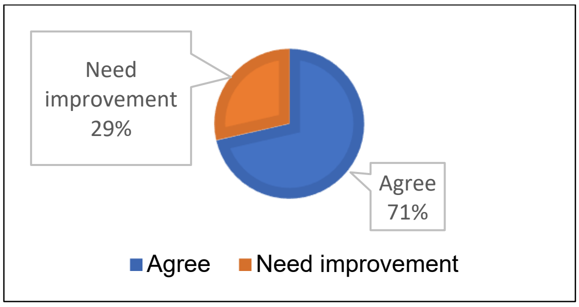


Figure 2: Pie Chart illustrates the Acceptability of the Attributes

Most experts keep the approval views on the listed attributes of the highest ranking (Table 4). On the other hand, experts A3, A6, A10 and A13 proposed that the listed attributes should be improved including revision and supplements.

Supplements

- ***Expert A3:*** *suggested including Data Volume as one of the attributes to be considered in this research where the data includes all the V5 of Big Data, which is the Volume, Variety, Velocity, Veracity and Value. Other than that,* *Expert A3 also suggested including the type of financing of the project such as government initiative or private funding. Besides that, Expert A6 also suggested Implications of Innovation and Technology such as BIM, Digital fabrication and automation, robotics, etc.*

- ***Expert A6:*** *suggested Contingency cost as one of the attributes to be included in the sets of attributes.*

Revision

- ***Expert A10:*** *suggested simplifying the attributes that are quite similar to each other. For Example, attributes like Level of Design Complexity and Shape Complexity can be integrated into a single attribute as a 'Design Complexity'. Another suggestion that the Panel Expert made is the integration between the Building Area to be Gross Floor Area, as the meaning of the two attributes is quite similar. Therefore, with this suggestion, we need to take into consideration any attributes that might have a similar meaning and can be integrated together as 1 attribute.*

- ***Expert A13:*** *suggested ranking the categories instead of each of the attributes. For example, if the Design-related attributes are mostly ranked at the top, then the categories of the attributes as a whole are put at the very top and thus accordingly. However, the attributes are not equally distributed, and this method may need another round of the Delphi method, which may take a longer time to reach out to each of the Panel Experts, therefore, this might be done in further research.*

Therefore, taking into account the second round of the Delphi study in coming up with the standard sets of attributes, whereby focus group discussion is conducted to validate the findings. Figure 3 finalises sets of attributes that can be utilised in developing a cost estimation model of machine learning.

To summarize the above findings, 68 finalised attributes have been formed as the standard sets of attributes for developing a building cost estimation model by machine learning algorithm. However, the listed attributes could also be revised based on the specific project's condition, relevant cost estimation researchers can refer to this attribute set to complete the step of the Business Understanding regarding the CRISP-DM model when establishing a machine learning model.

CONCLUSION

Current cost estimation techniques (e.g., traditional and probabilistic methods) can not satisfy the requirement of the construction industry due to the need for a more accurate result, more and more scholars gradually focus on the usage of machine learning techniques to develop innovative cost estimation models. Importantly the attribute set of building data is the basis of subsequent research regarding the CRISP-DM model, so this research aims to clarify the attribute set of building data by using Delphi methods with 2 rounds. By questionnaire surveying and focus group discussion of the Delphi study period, the final 68 ranked attributes were determined and formulated to the attribute set of building data. The findings of this research are beneficial to improve the accuracy of estimation by providing the essence of developing a building cost estimation of machine learning because the domain researcher can refer to these listed attributes to determine the layer structure of a new model.

Funding: Funded by the Ministry of Higher Education, Fundamental Research Grant Scheme (FRGS), Project No. FP087-2022.

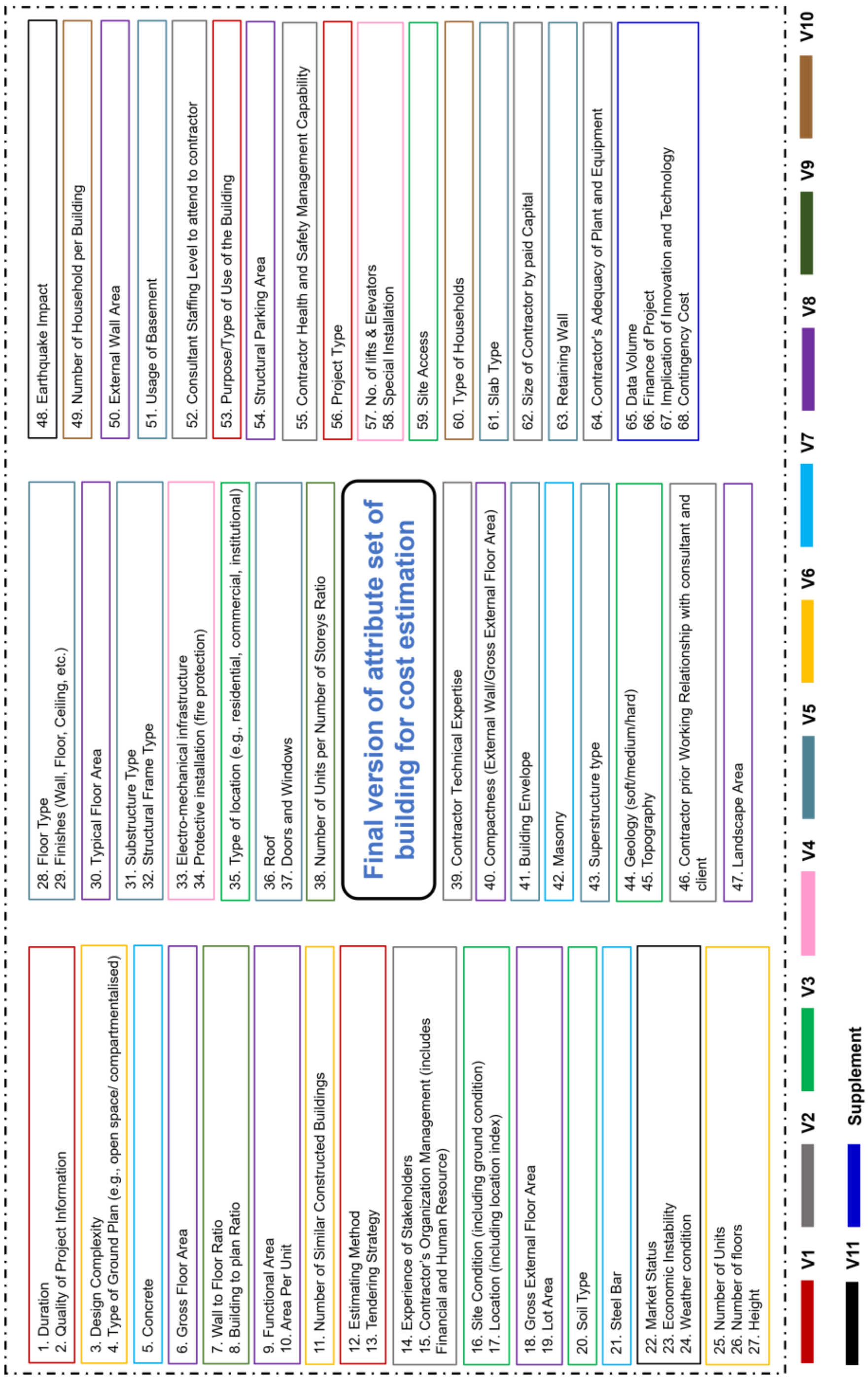


Figure 3: Final version of attribute set of building for cost estimation

REFERENCES

Abed, Y. G., Hasan, T. M., & Zehawi, R. N. (2022). Machine learning algorithms for constructions cost prediction: A systematic review. *INTERNATIONAL JOURNAL OF NONLINEAR ANALYSIS AND APPLICATIONS*, *13*(2), 2205–2218. https://doi.org/10.22075/ijnaa.2022.27673.3684

Ahiaga-Dagbui, D. D., & Smith, S. D. (2014). Rethinking construction cost overruns: Cognition, learning and estimation. *Journal of Financial Management of Property and Construction*.

Ahn, J., Ji, S.-H., Park, M., Lee, H.-S., Kim, S., & Suh, S.-W. (2014). The attribute impact concept: Applications in case-based reasoning and parametric cost estimation. *Automation in Construction*, *43*, 195–203.

Al-Khaldi, Z. S. (1990). *Factors affecting the accuracy of construction costs estimating in Saudi Arabia*. King Fahd University of Petroleum and Minerals (Saudi Arabia).

Alshemosi, A. M. B., & Alsaad, H. S. H. (2017). Cost estimation process for construction residential projects by using multifactor linear regression technique. *Criterion*, *71*, 7.

Amin, M. (2017). Development of cost estimation model for residential building. *Int J Civ Struct Eng Res*, *5*(1), 1–4.

An, S.-H., Kim, G.-H., & Kang, K.-I. (2007). A case-based reasoning cost estimating model using experience by analytic hierarchy process. *Building and Environment*, *42*(7), 2573–2579.

Arafa, M., & Alqedra, M. (2011). Early stage cost estimation of buildings construction projects using artificial neural networks. *Journal of Artificial Intelligence*, *4*(1), 63–75.

Bala, K., Ahmad Bustani, S., & Shehu Waziri, B. (2014). A computer-based cost prediction model for institutional building projects in Nigeria: An artificial neural network approach. *Journal of Engineering, Design and Technology*, *12*(4), 519–530. https://doi.org/10.1108/JEDT-06-2012-0026

Bhokha, S., & Ogunlana, S. O. (1999). Application of Artificial Neural Network for the forecast of building cost at the pre-design stage. *Seventh East-Asia Pacific Conference on Structural Engineering and Construction, Kochi, Japan*.

Car-Puši, D., & Mladen, M. (2020). *Early Stage Construction Cost Prediction in Function of Project Sustainability*. 631–638. Scopus. https://doi.org/10.23967/dbmc.2020.048

Chan, S. L., & Park, M. (2005). Project cost estimation using principal component regression. *Construction Management and Economics*, *23*(3), 295–304.

Cheng, J. C. P., Law, K. H., Zhang, Y., & Han, C. S. (2010). WEB-ENABLED MODEL-BASED CAD FOR THE ARCHITECTURE, ENGINEERING AND CONSTRUCTION INDUSTRY. In J. Teng (Ed.), *PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE ON SUSTAINABLE URBANIZATION (ICSU 2010)* (pp. 1199–1208). HONG KONG POLYTECHNIC UNIV, FAC CONSTRUCTION & ENVIRONMENT.

Cheng, M.-Y., & Wu, Y.-W. (2005). Construction conceptual cost estimates using support vector machine. *22nd International Symposium on Automation and Robotics in Construction ISARC*, 1–5.

Doğan, S. Z., Arditi, D., & Günaydın, H. M. (2006). Determining attribute weights in a CBR model for early cost prediction of structural systems. *Journal of Construction Engineering and Management*, *132*(10), 1092–1098.

Doğan, S. Z., Arditi, D., & Murat Günaydin, H. (2008). Using decision trees for determining attribute weights in a case-based model of early cost prediction. *Journal of Construction Engineering and Management*, *134*(2), 146–152.

Elfaki, A. O., Alatawi, S., & Abushandi, E. (2014). Using intelligent techniques in construction project cost estimation: 10-year survey. *Advances in Civil Engineering*, *2014*.

Elhag, T. M. S., & Boussabaine, A. H. (1998). An artificial neural system for cost estimation of construction projects. *14th Annual ARCOM Conference*, *1*, 219–226.

Elmousalami, H. H. (2020). Artificial intelligence and parametric construction cost estimate modeling: State-of-the-art review. *Journal of Construction Engineering and Management*, *146*(1), 03119008. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001678

El-Sawalhi, N. I., & Shehatto, O. (2014). A Neural Network Model for Building Construction Projects Cost Estimating. *Journal of Construction Engineering and Project Management*, *4*(4), 9–16. https://doi.org/10.6106/JCEPM.2014.4.4.009

Emsley, M. W., Lowe, D. J., Duff, A. R., Harding, A., & Hickson, A. (2002). Data modelling and the application of a neural network approach to the prediction of total construction costs. *Construction Management & Economics*, *20*(6), 465–472.

Feng, G. L., & Li, L. (2013). Application of Genetic Algorithm and Neural Network in Construction Cost Estimate. *Advanced Materials Research*, *756–759*, 3194–3198. https://doi.org/10.4028/www.scientific.net/AMR.756-759.3194

Hashemi, S., Ebadati E., O. M., & Kaur, H. (2020). Cost estimation and prediction in construction projects: A systematic review on machine learning techniques. *SN Applied Sciences*, *2*, 1–27. https://doi.org/10.1007/s42452-020-03497-1

Hong, T., Hyun, C., & Moon, H. (2011). CBR-based cost prediction model-II of the design phase for multi-family housing projects. *Expert Systems with Applications*, *38*(3), 2797–2808.

Ji, S.-H., Ahn, J., Lee, H.-S., & Han, K. (2019). Cost estimation model using modified parameters for construction projects. *Advances in Civil Engineering*, *2019*.

Ji, S.-H., Park, M., & Lee, H.-S. (2011). Cost estimation model for building projects using case-based reasoning. *Canadian Journal of Civil Engineering*, *38*(5), 570–581.

Jiang, Q. (2019). Estimation of construction project building cost by back-propagation neural network. *Journal of Engineering, Design and Technology*, *18*(3), 601–609. https://doi.org/10.1108/JEDT-08-2019-0195

Jin, R., Cho, K., Hyun, C., & Son, M. (2012). MRA-based revised CBR model for cost prediction in the early stage of construction projects. *Expert Systems with Applications*, *39*(5), 5214–5222. https://doi.org/10.1016/j.eswa.2011.11.018

Jumas, D., Mohd-Rahim, F. A., Zainon, N., & Utama, W. P. (2018). Improving accuracy of conceptual cost estimation using MRA and ANFIS in Indonesian building projects. *Built Environment Project and Asset Management*, *8*(4), 348–357.

Kim, G.-H., An, S.-H., & Kang, K.-I. (2004). Comparison of construction cost estimating models based on regression analysis, neural networks, and case-based reasoning. *Building and Environment*, *39*(10), 1235–1242.

Kim, S., & Shim, J. H. (2014). Combining case-based reasoning with genetic algorithm optimization for preliminary cost estimation in construction industry. *Canadian Journal of Civil Engineering*, *41*(1), 65–73. https://doi.org/10.1139/cjce-2013-0223

Latief, Y., Wibowo, A., & Isvara, W. (2013). Preliminary cost estimation using regression analysis incorporated with adaptive neuro fuzzy inference system. *International Journal of Technology*, *1*, 63–72.

Lu, Y., & Zhang, J. (2022). Bibliometric analysis and critical review of the research on big data in the construction industry. *ENGINEERING CONSTRUCTION AND ARCHITECTURAL MANAGEMENT*, *29*(9), 3574–3592. https://doi.org/10.1108/ECAM-01-2021-0005

Pike, J., & Grosse, S. D. (2018). Friction Cost Estimates of Productivity Costs in Cost-of-Illness Studies in Comparison with Human Capital Estimates: A Review. *Applied Health Economics and Health Policy*, *16*(6), 765–778. https://doi.org/10.1007/s40258-018-0416-4

Riquelme, P., & Serpell, A. (2013). Adding Qualitative Context Factors to Analogy Estimating of Construction Projects. *Procedia - Social and Behavioral Sciences*, *74*, 190–202. https://doi.org/10.1016/j.sbspro.2013.03.037

Schröer, C., Kruse, F., & Gómez, J. M. (2021). A systematic literature review on applying CRISP-DM process model. *Procedia Computer Science*, *181*, 526–534.

Shin, Y. (2015). Application of boosting regression trees to preliminary cost estimation in building construction projects. *Computational Intelligence and Neuroscience*, *2015*, 1–1. https://doi.org/10.1155/2015/149702

Sonmez, R. (2004). Conceptual cost estimation of building projects with regression analysis and neural networks. *Canadian Journal of Civil Engineering*, *31*(4), 677–683.

Wirth, R., & Hipp, J. (2000). CRISP-DM: Towards a standard process model for data mining. *Proceedings of the 4th International Conference on the Practical Applications of Knowledge Discovery and Data Mining*, *1*, 29–39.

Received: 7th June 2023. Accepted: 5th September 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 126 – 140

EVALUATING PUBLIC COMPLIANCE WITH WILDLIFE CONSERVATION LAW IN WUHAN, CHINA

Amir Hamzah Sharaai[1*], Zha Yujing[2], Wafaurahman Wafa[3], Ma Sining[4], He Zhijian[5]

[1,2,3,4]*Faculty of Forestry and Environment,*
[5]*School of Business and Economics,*
UNIVERSITI PUTRA MALAYSIA

Abstract

As a result of the outbreak of COVID-19 in mainland China, the governments expedite the legislation of the Wildlife Protection Law (WPL) by proposing a comprehensive prohibition on wildlife eating and trading in the latest WPL due to the potential association between the outbreak and wildlife. However, the prohibition could affect the current social-economic system, leading to a void of legislation due to the disobedience of laws in society. Public readiness toward the law has a strong relationship with expected obedience to it. Therefore, the objectives of this study are to assess the two components of the readiness knowledge about the law and the readiness toward the actions potentially contradicting the latest WPL. Another objective is to collect participants' opinions and reasons on whether they think the latest WPL is difficult to enforce. By selecting the epicenter Wuhan as a study site, voluntary response sampling was used to distribute the questionnaire online. The data obtained from 410 respondents show that the citizens in Wuhan have average knowledge about the latest WPL but are unaware of the definition of wildlife. Based on the Mann-Whitney test, the study found no significance between gender and knowledge, but it exists in all other comparisons. Moreover, the significance only exists between readiness scale and age groups. The difficulty in enforcing the latest WPL underlines the problems in enforcement, awareness, demand, and society aspect, while on the opposite, respondents highlight the lesson from the pandemic and belief in the governments. In conclusion, citizens in Wuhan show a medium readiness toward the latest WPL, which is vital to design optimal legislation.

Keywords: Wildlife Protection Law, Wildlife Trade, Knowledge, Readiness, Enforcement, Awareness

[1] Corresponding author E-mail: amirsharaai@upm.edu.my

INTRODUCTION

Since the end of 2019, a mysterious pneumonia that sparked a dozen cases of infection in a very low profile in the central part of China, Wuhan, has been rapidly out of control and spread throughout the world at an unimaginable transmission speed (Baharuddin & Zuhairi, 2021; Huang et al., 2020). Furthermore, With the high capability to transmit from human to human, the virus now has a notorious name: COVID-19, which caused the total confirmed infection cases of more than 71 million and death tolls of 1,601,088 in aggregate globally as of December 12, 2020 (Worldometer, 2020). Apart from the readiness of professionals and scholars about the Wildlife Protection Law (WPL) among society, ordinary citizens from all walks of life, constitute the largest part of recipients of the law. Their readiness toward the law acts as an extent to which the law and relevant enforcement have an optic effect on society (Li, 2007).

Wuhan is an important transportation hub and one of the largest cities in central China. It is a very wealthy city that contributes prominently to China’s GDP. The city’s medical resources, including the number of hospital beds and specialized hospitals, are very rich. However, even such a not weak medical and health system was still overwhelmed when the epidemic hit and was on the verge of collapse (Siwen, 2020).

As the center of the pandemic, the Huanan Seafood Wholesale Market of Wuhan drew the attention of the world and put the illegal wildlife trade under the spotlight. Almost all of the wildlife trade in the market served as raw materials in human's kitchen, including bat, which has been identified as the potential host of COVID-19 (Peng et al., 2020; Zhou et al., 2020), snake, and some very precious wild animals, such as pangolin, which is also on the suspect list of intermediate hosts of coronavirus (Zhang et al., 2020).

Before the modern concept of wildlife protection was brought to China from overseas, the traditional belief held by Chinese people widely was that wildlife is a major source of food and medicine (Zhang et al., 2008). Until the early 1980s, hunting activity was legally permitted in China due to the desperate demand for foreign currency of the government in the impoverished period when the whole nation was suffering from overwhelming social unrest (the Cultural Revolution) and the breakdown of domestic economic production. Admittedly, the government earned millions of dollars in replacement of biodiversity. For example, Qinghai province opened the gate for foreign hunters to enjoy the natural reserve game in 1987, and the population of musk deer plunged from about 3 million in the 1950s to less than 1 million within 30 years under the flag of legal hunting for the valuable musk (CWE, 1989). Since the first edition of the Wildlife Preservation Law issued in 1989 came into force, such rampant hunting was officially banned by the Chinese government, but the effectiveness of the law for protecting wildlife is always doubted by the public.

Therefore, the study objective is: 1) to assess the citizens' knowledge level about the implementation of the latest WPL and the basic legal system of the People's Republic of China, 2) to nalayye the reasons given by respondents about the enforcement of the latest WPL, and 3) to assess the level of readiness among the people for the anticipated implementation of important legislation.

LITERATURE REVIEW

About 80 studies were chosen out of hundreds throughout the systematic literature review. The literature ranges from qualitative studies of legislative analysis and epidemy records to quantitative studies of environmental awareness or animal protection attitudes. Qualitative studies were used to identify the progression of the WPL in mainland China and the significant change in mainland China's society and economics, while quantitative studies highlighting the relationship between environmental law and environmental awareness, attitude, and knowledge, especially in the wildlife protection sector, were compared to the current study in the data analysis section.

A report from the administrative department that found 17,000 Himalayan ibex skins and 1,100 kg of shahtoosh in the first decade after WPL was published. This figure shamed the WPL and questioned its legitimacy and efficacy. The law punishes and imprisons violators, but WPL's principles of "breeding, domestication, and utilization" and "equivocation of law" in legislation limit its utility. For 30 years, Chinese academics, biologists, and environmentalists have demanded WPL modification. McBeath (2006) noted that many legislative council members lack the biological and ecological expertise to implement scientific WPLs. After three years of study and consultation on the first revised WPL, the Chinese government suggested the second edition in 2016. Public readiness was crucial to this amazing success in China's legislative history, notwithstanding a few intractable issues like tiger and bear farm permits (Li, 2007).

Moreover, 70% of Chinese respondents believed pangolin pieces may treat skin and wound problems (Wildaid, 2019). However, pangolins are not as medically useful as people think. In his "Bencao Gangmu" (Compendium of Materia Medica), Ming dynasty sage Li Shizhen warned that eating pangolin could cause persistent diarrhea. This compilation also advises against eating wild animals like bats, snakes, and boars, which are still a secret recipe in many Chinese kitchens but are thought to spread infectious diseases like the current COVID-19 pandemic (A. et al., 2011; Rosni & Zainol, 2022). Chinese people have strong convictions because their forefathers condone wild animal medicine.

The Chinese government bans all illegal wildlife trade in the country and corrects the anachronistic habit of Chinese people eating wild animals in response to public demand for wildlife trade control measures. In February, the National People's Congress produced a file (The Decision) to reflect the government's decision (National People's Congress, 2020). The file urges all societal groups to participate in education, campaign, and guidance to improve citizens' readiness to protect ecosystems and enforce the WPL. Except for actual punishment of illegal hunting and trafficking, law enforcement depends on public readiness (Copper, 2007).

RESEARCH METHODOLOGY

Wuhan is located in the center of China's hinterland, in the eastern part of Hubei Province, at the intersection of the Yangtze River and the Han River. It is a national historical and cultural city, the central city and the only sub-provincial city in central China, and an important industrial base, science and education base and comprehensive transportation in the country， is also the capital of Hubei Province. The geographical location is 113°41′～115°05′ east longitude and 29°58′～31°22′ north latitude. The city's land area is 8569.15 square kilometers. The construction area is 885.11 square kilometers. At the end of 2021, the city's permanent population was 13.6489 million (WuHan.China, 2022). According to the data from the Statistic Bureau of Wuhan (2019), 11.2 million population lives in the city.

Figure 1: The map of Wuhan

To determine the total sample size of the population in Wuhan, the formula for calculating the sample size devised by (Krejcie & Morgan, 1970) was applied for the determination of the amount of questionnaire that was allocated. To ensure an adequate sample size in Wuhan, 450 questionnaires were distributed, exceeding the minimum requirement of 385 respondents. An additional 65 sets were allocated to account for potential invalid or non-responsive responses.

The study comprises four sections. The first section collected demographic information, including gender, age, hukou (a government-issued sheet indicating legal domicile), education, and employment. The second section assessed knowledge about the Wildlife Protection Law (WPL) and related topics through eight objective questions. These questions covered legislative processes, WPL implementation, amendments, and the definition of wildlife. The third section examined respondents' attitudes and readiness towards the latest WPL contents with six Likert-scale questions. The final section featured an open-ended qualitative question to gather subjective opinions on challenges related to law execution in China.

Validity and Reliability of the Research Instrument

Validity

The questionnaire used for data collection was subjected to several stages of validation and reliability check. At the outset of data collection, the draft was sent to five validators based on their expertise either in legal system or sociology contributed for quality checking. Based on the respective expertise either in the legal system or sociology, validators contributed a few suggestions in terms of the specific term-using, the appropriate sequence of questions, and even the alternative customary word-using in mainland China, which otherwise could have evoked confusion on the question.

Reliability

A pilot study can be defined as a "small study" to test research protocols, data collection instruments, and other research techniques in preparation for a larger study to reveal the internal consistency of the project (Hassan et al., 2006). A pilot study with 75 participants was conducted prior to formal data collection, and the participants were more than the reasonable minimum of 30 respondents from the population (Johanson & Brooks, 2010). Cronbach's Alpha test was used to check the reliability of Likert-scale questions in Section 3, indicating the acceptable quality for the internal consistency of questions (Alpha = .709).

Data Collection

Data collection in Wuhan involved random selection of respondents through WeChat's platform for voluntary response sampling. Tencent distributed the online survey to potential respondents with WeChat accounts through the public "Tencent questionnaire" account. Automated target selection matched researcher preferences with WeChat user data. Using a "location preference" screening condition, the study ensured that participants were from Wuhan. It was optional for respondents to complete the questionnaire. For efficient quantitative data collection, the survey primarily employed closed-ended questions, such as Likert scales, and multiple-choice questions to assess respondents' knowledge. All data collected were kept strictly confidential and used for research purposes only.

Data Analysis

Quantitative data are made of the value of data in the form of numbers associated with the unique value for each of them. The quantifiable data from Likert-scale questions and objective questions can be used for mathematical calculations and statistics, and the questions on the attitude-revealing part can be made based on these mathematical derivations.

The interval data gained from Section 2 are perfectly appropriate to the mean-based comparison approaches. However, the ordinal data obtained from Section 3, which are composed of a ranking scale from 1 (strongly disagree) to 5 (strongly agree) about different statements, are used to assess the potential readiness of the participants toward a certain influence brought by the latest WPL. The responses of this section were transformed into a 5-point Likert scale and assigned with numeric values from 1 to 5. The median of each question assessed readiness for the newest Wildlife Protection Law through quantitative data analysis. Cross-tabulation in Excel and SPSS revealed variable correlations. Sequencing variables by scale (ordinal, nominal, interval) was crucial before data entry. Mean, percentage, and frequency were utilized to process data. In Section 2's knowledge scale, Mann-Whitney U-test and Kruskal-Wallis H-test were used to assess factors' effects on characteristics. When data were not regularly distributed, except interval data scales, non-parametric tests were utilized.

ANALYSIS AND DISCUSSION

Demographic Information

About 59.3% of the respondents are male, and the rest are female. As for the age distribution among the respondents, 19.5% of the respondents aged between 26 and 40 years old, and 78.3% of the respondents are in the range of 18–25 years old. With regard to education, over 90% of the respondents graduated from university or above. Among that, people with bachelor's degree covered the largest portion, up to 54.1%, compared to those with college diploma (27.3%), which is relatively lower than the bachelor's degree in China's education system, though both are generally called “university students”. The master's degree holders comprised 9.8% of the total respondents, and PhD holders contributed to the lowest share with only 1.7%. Meanwhile, others (below college diploma) accounted for 7.1% of those educational survey.

The Chinese government categorizes its citizens roughly into two groups: one is urban, while another is non-urban. This sorting method has been widely known as hukou, which defines the holders of hukou based on their address or the place where they were born in order to restrict the migration of the population and to allocate resources more effectively and wisely (official declaration). The study did not find a significant difference between the percentage of both groups (urban (54.4%) versus non-urban (45.1%)). Most of the respondents (56.8%) are students in campus, which explains the reason for the majority (42.2%) of the respondents who have yet to receive any income. Subsequently, 26.7% of the respondents worked at private or foreign companies, while 17.1% are employed in the state-owned or government-owned sector, or as civil servants. Except for those without income, 32% made yearly earning less than 60,000 yuan (8,919 dollars). 16.1% of the respondents have income in the range of 60,000–99,999 (14,865 dollars), while only 10% of the respondents received more than 100,000 yuan annually.

Knowledge of Regulatory Protection of Wildlife

More than half (51%) of the respondents answered that they seldom heard The Decision despite the frequent media reports about The Decision and the unique epicenter where the respondents are living, whereas the rest (49%) acknowledged that they had heard The Decision frequently. Only two-fifths of the respondents expressed their concern about the latest term of forbidding wildlife-dinning, which is expected to be the crucial topic of the revised WPL. Other options, including a complete prohibition on trading, hunting, and breeding wildlife, though sound legit, are neither priority of the revised WPL nor any actual prescription according to the current articles of WPL, and 17.7% answered that they did not know about the central point of the revised law.

However, this finding shows that a lot of Chinese people are apathetic about the new rule and do not want to learn about it or study the article that they are supposed to enforce. It shows that the main concept of law has always been much more peripheral in Chinese mentality than in Western countries, with most Chinese individuals' mindset regarding any social problem being lawless (Harris, 2014).

Only a small portion of the respondents answered the question “which branch is in charge of legislation regarding WPL” correctly (12.7%). More than half of the respondents chose the answer “I do not know” (55.1%), and the rest selected the wrong answers. In addition, there is almost a doubled correct rate (21%) in the question “which branch is in charge of enforcement regarding WPL”, yet the option “I do not know” still occupied the majority of responses (53.9%).

Slightly more than one-third of the respondents selected the right answer to the question intended to know people's basic knowledge about the definition of wildlife in terms of the WPL. Interestingly enough, for the wild animal options which were purposely manipulated with the terms "captive breeding", only a little fraction of the respondents chose these options (4.4% and 3.4%, respectively), while for the animal without the terms, almost half (49.3%) of the respondents thought it is categorized as wildlife. However, given the definition of the WPL, wildlife means the animals live and thrive in the wild regardless of captive breeding. Likewise, 31.2% of the respondents answered correctly to the question of the justification of the wildlife-eating action, and the rest chose wrongly due to restricted comprehension of the definition of wildlife. For the definition of "national protected wildlife", 46.8% of the respondents selected the right answer, which is the highest proportion among all questions regarding knowledge about the WPL. Finally, the last question in this section also shows that most of the respondents (30.7%) knew what sort of action is illegal, higher than the percentage of the other four options. The items on knowledge can be further classified into provisions and access related to the WPL, basic knowledge of legislative work, and the definitions of WPL.

Association of Sociodemographic Factors with Knowledge

A Mann-Whitney test was conducted to compare the knowledge level of the male and female respondents. There was no significant difference in scores for the male and female respondents (U = 20881.5, p = .606). These statistics infer that gender does not have an effect on the level of knowledge about the WPL. In contrast, there was a significant difference in scores for the respondents from urban and non-urban areas (U = 17,765.0, p = .013. These data suggest that hukou (birthplace) has an obvious effect on the level of knowledge about the WPL. Given the responses from the question "whether you have heard "The Decision" or not", these data also demonstrated a significant difference in scores for those answering "always" and those stating "seldom" (U = 18,634.5, p = .042), which implies that the level of knowledge depends on the extent to which people tend to concern about "The Decision". Kruskal-Wallis H-test between subjects was conducted to identify the effect of age on the level of knowledge of the WPL. Four categories (1: 18–25, 2: 26–40, 3: 41–60, and 4: above 60) were used to sort all respondents according to their age. In the test, p <.05 for the four age categories ($\chi 2(3)$ = 13.004, p = .005), with a mean rank knowledge score of 197.2 for 18–25, 240.46 for 26–40, 227.19 for 41–60, and 49 for above 60. There is a statistically significant effect of age on the level of knowledge. Based on these findings, a hint of similarity was identified with a study that found a significant difference that only arose from half of all age categories with the knowledge of pangolin protection (Ariffin & Nan, 2018). Another Kruskal-Wallis H-test was conducted to examine the effect of employment on the knowledge of the WPL. The respondents' employment was classified into four categories: Category 1) college students; Category 2) civil servants; Category 3) employment in the state-owned sector, and Category 4) employment in the private sector. There is a statistically significant difference between employment and level of knowledge, as proven by the test ($\chi2(3) = 9.685$, $p = 0.021$), with a mean rank knowledge score of 194.02 for college students, 194.46 for civil servants, 252.20 for the state-owned sector, and 221.53 for the private sector. Likewise, in the educational background, the Kruskal-Wallis H-test also shows the significance with knowledge level ($\chi2(4) = 10.331$, $p = 0.035$), with a mean rank knowledge score of 187.53 for college diploma, 214.95 for bachelor's degree, 234.05 for master's degree, 199.14 for PhD, and 164.72 for others.

Although knowledge and understanding of environmental law always play a vital role in people's attitude and acceptance toward the law, the execution and public compliance with the law are also indispensable in wildlife protection. In the wake of the relationship between gender and knowledge level on the WPL, this study discovered no significant disparity between male and female respondents. However, previous research found that female respondents illustrate stronger concern about environmental affairs (Czech et al., 2001).

With regard to the hukou (birthplace), a study also found a significant difference between non-residents and residents in the wildlife conservation zone (Guzman et al., 2020). This research reinforces the argument that people who live in conservation zones adjacent to a wide variety of wildlife do not necessarily have higher awareness or knowledge level than those living far away from those zones. People's willingness to access the latest information on regulation also affects their knowledge level, and the question "have you heard of The Decision" cannot be waived by the explanation of the problem in accessing the information when the respondents have handphone to answer the questionnaire. In addition, this study also found a significant disparity between age groups and employment groups. Interestingly, the current study shows that civil servants who have the strongest bond to the government do not have a significant difference in the level of knowledge about the WPL from other employments.

Readiness on Compliance with Proposed Provisions

Compliance is hard to achieve if the new law proscribes customary activities a lot. Traditional Chinese medication, which comprises a lot of animal-related prescriptions, is broadly recognized as a competent alternative to contemporary medical science in the Chinese community. Additionally, several types of animals always appear in Chinese recipes, such as bear's paw and stewed snake, which are also thought of as good health supplement. The major content of The Decision is to enforce comprehensive prohibition on animal-eating, thus is undoubtedly against the traditional medicine or bizarre food for gourmands using animals or their parts. A certain degree of disturbance in society is expected to be in place by promoting The Decision. Nonetheless, a lack of public compliance and readiness will surely make the rules impractical (Keane et al., 2008). The extent to which people are ready to comply with the latest WPL affects its enforcement. In the current study, the respondents were asked about their readiness to obey the proposed WPL by rating the scale from 1 to 5 on how much they agree with the statements given.

Table 1: Readiness scale

Statements	Median
I am very confident in the transparency of the enforcement against illegal activities.	4.00
I can refrain from any purchase of commodity made up of wildlife.	5.00
I do not believe in the special medical value of products made up of wildlife.	3.00
I do not believe in the unique nourishment of food made up of wildlife.	3.00
I can totally refrain from consuming any kind of wildlife for food.	5.00
I am aware of the potential impacts of the new law on my life very well.	3.00

Where 1 is the most negative scale (strongly disagree) and 5 is the most positive scale (strongly agree). Thus, the higher the mean score, the more the respondents are ready to embrace the proposed WPL. In Table 1, the results show that the respondents are ready to obey the law regarding provisions against purchasing commodities made up of wildlife or its parts and consuming wildlife for food, while for the potential impact brought by the law, it attains the lowest score with only 3, meaning that they actually do not know how the proposed WPL will change their life. The results of the medical value and nourishment of wildlife are in the lowest scale 3 (neutral), indicating that the respondents also have a vague realization about the utilization of wildlife. The transparency of enforcement against illegal activities achieved a score of 4, higher than the neutral scale and almost achieving the agreed scale. Above all, despite the roughly neutral attitude toward some aspects of the law, the respondents overall show positive readiness to the proposed WPL.

Readiness in Sociodemographic Factors

To compare readiness toward compliance with the proposed WPL, Mann-Whitney U-test was performed to identify the difference between gender. There was no significant difference in the scores for males and females (U = 18,369.0, p = .102), suggesting that gender does not have a significant effect on the readiness toward the new law's enforcement. Likewise, in another statistic of the sample, the test was run to detect disparity between hukou, and no significant difference was observed among the respondents born in urban and non-urban areas (U = 19,063.0, p = .186). Finally, for the question "have you heard about The Decision", the t-test shows a significant difference between those who have heard a lot and those who chose "hardly heard about that" with U = 15,186.5, p = .00. These results indicate that the motivation to follow law-related news has an effect on the readiness toward the new legislation.

The Kruskal-Wallis H-test was used to compare the difference between the mean of collections. Firstly, for age and readiness, four identical age categories with the one used in the knowledge section were compared with the scales. The results show a significant difference among the ages ($\chi2(3) = 9.422$, $p = .024$), with a mean rank readiness scale of 198.56 for 18–25, 231.24 for 26–40, 260.63 for 41–60, and 66.25 for above 60. Next, it was also applied to compare the effect of employment on the respondents' readiness toward the new law. However, the results of $\chi2(3) = 5.055$, $p = .171$ with a mean rank readiness scale of 197.83 for college students, 196.61 for civil servants, 243.68 for the state-owned sector, and 214.81 for the private sector do not show any significant difference on the four categories. Finally, the difference between the respondents' educational background and their readiness is worth to be examined. Nonetheless, the results also show no significant difference between educational background and readiness for the five categories (college, bachelor, master, PhD, and others); $\chi2(4) = 1.600$, $p = .809$, with a mean rank readiness scale of 205.22 for college students, 209.14 for bachelor's degree, 204.60 for master's degree, 163.29 for PhD, and 190.10 for others.

Overall, this study found that the respondents are roughly ready for the enforcement of the proposed WPL with the mean slightly below or higher than the neutral position to the contents of the law. Among those sociodemographic factors, age is the only one with a significant effect on the respondents' readiness toward the enforcement of the new law. In addition, the motivation to know about the new law is another factor affecting respondents' readiness toward the new law. However, by comparing the questions in the knowledge section and in the readiness section, it was found that the respondents who rated 4 and 5 in "completing refusing wildlife-eating" (101 respondents agreed and 256 respondents strongly agreed) stated that they can stay away from eating wildlife, and only 37 and 70 respondents chose the right answer in the question asking to differentiate the action of eating wildlife, respectively. Likewise, by comparing the scale statement of "completely refusing purchase of wildlife product" and the question asking to differentiate the type of wildlife, the result shows that for those selecting 4 and 5, only 35 out of 105 and 104 out of 269 respondents chose the right answer, respectively. Both findings imply that respondents with a high level of readiness toward the enforcement of the proposed WPL do not necessarily have enough knowledge about the law.

Reasons from the Respondents about the Enforcement of the Latest WPL

This section is set up to explicate reasons given by the respondents why they think the proposed WPL is difficult or easy to comply with, and whether the proposed WPL is difficult to execute or not. From the results, 14 respondents answered, "I do not know", "I am not clear", and "Wu" (no opinion), and thus were excluded from qualitative coding. Meanwhile, 124 respondents left clear text with a positive view on the compliance and enforcement of the proposed WPL, whereas most of the respondents (272) expressed worries and concerns about the new law.

By following certain steps, similar words and phrases were extracted from the answers and were used to constitute themes. Theoretical constructs, such as Enforcement and Awareness, were then concluded from similar themes before the final theoretical narratives were carried out (I and II) (Auerbach & Silverstein, 2003).

Table 2: Repeating reasons for the enforcement of the latest WPL

I Think the Latest WPL is Difficult to Enforce	I Think the Latest WPL is not Difficult to Enforce
Lack of resources, transparency, and penalty affect the enforcement of the new law. The new law is hard to enforce in all corners of China due to its massive population and land. Illegal wildlife trade in black markets is always hidden from official's view.	People's awareness of wildlife protection is rising after the pandemic. People will stop eating wildlife because of the realization of the harm. The government will impose stricter enforcement after the pandemic.
People do not acquire an awareness of wildlife protection yet. Every single person has different awareness of law and wildlife protection.	The government will enforce the law completely in each case. People will comply with the law closely in each case.
There must be a corresponding supply due to the huge demand for wildlife products. Substantial profit of illegal wildlife trade makes people risk attempting to commit crimes.	
People still possess the inveterate habit of eating animals even after the pandemic. Wealthy people are eager to boast about their status by consuming wildlife products.	

In Table 2, two types of theoretical narratives are the law is difficult to enforce and the law is not difficult to enforce, which are extracted from the reasons given by the respondents: Shi (the enforcement will meet difficulties) and Fou (the enforcement will not meet difficulties). The keywords in the responses constitute the theoretical constructs, for example, Zhi fa li du (enforcement), Ren ming yi shi (awareness), and Mei you mai mai jiu mei you sha hai (no trades no kills, demand), where these repeating ideas brought up different themes. A review of the data also found that those who think there are difficulties in enforcing the new law tended to give detailed reasons, while those who think there is no difficulty were likely to give only Fou without giving any specific reasons.

Based on the main reasons obtained from raw responses, the participants mentioned a wider variety of reasons about the difficulty in enforcement of the latest WPL than the reasons about no difficulty in enforcement. In the enforcement part, the participants are concerned about the problem hidden in the transparency and weaknesses of the current enforcement of the WPL. Formerly, wildlife was regarded as a natural resource decades ago, serving the purpose of utilization by humans due to the unique demand for wildlife. Thus, it is not strange that the WPL contains provisions compromising its enforcement per se because the concept of utilizing wildlife has been rooted in their mind. Consequently, in the demand part, the respondents have a pessimistic attitude toward the expected enforcement of the latest WPL. If the demand exists in the market, the supply shall arise from anywhere regardless of the legality, and the hardened illegal trade of wildlife is normally concealed from supervision and public view. In the awareness part, the participants expressed varying thoughts of awareness of wildlife protection among individuals, which could act as a main reason that holds back the understanding of the law and hinder effective enforcement. In the society part, people expressed a similar concern as in the awareness part, claiming that the deep-seated habits of Chinese citizens contradict the purpose of the latest WPL.

On the other hand, those respondents who thought that the enforcement of the latest WPL is not difficult to achieve did not explain it in detail, and instead, most of the answers highlighted the situation of COVID-19 and simple faith in the law and the government. Some of them expressed that the tough lesson from the pandemic will enhance the people's awareness of protecting wildlife, and the government will impose stricter measures against illegal wildlife trade and govern people's behavior.

CONCLUSION

Legislation plays a vital law in protecting wildlife and human health in China. The scheduled WPL is about to compose unprecedented prohibitions on wildlife eating, and this new law could cause a profound impact on society. Citizens' knowledge and readiness toward the law are the indispensable elements the lawmakers should consider. However, regular promotion of knowledge of wildlife and relevant laws should be conducted periodically in university campuses due to the unexpectedly lower level of knowledge about the WPL. In addition, in the readiness part, the participants show lower readiness based on the neutral scale chosen regarding the special medical value and unique nourishment of wildlife. These long-standing beliefs in the specialty of wildlife have become an important part of Chinese tradition, which also contribute to inveterate animal-eating habits among Chinese citizens. The current pandemic could convince a part of people to alter their minds, although a complete transformation in the realization of citizens needs a long time, waiting for the increase of average education level and the formation of a society with rules and laws.

Finally, the results suggest that both knowledge level and readiness among Chinese society toward the new law are at medium levels, giving the government a promising signal on the projected enforcement. Nevertheless, there is still a lot of space for the government to improve the feasibility of the law and the confidence of citizens in China's legal system.

REFERENCES

A., N., K.O, C., B., D., L.L, G., & A., M. I. (2011). Potential Biosites Of Significant Importance In Langkawi Geopark: Terrestrial Vertebrate Fauna. *PLANNING MALAYSIA*, *1*(1 SE-Article). https://doi.org/10.21837/pm.v1i1.93

Ariffin, M., & Nan, M. B. C. (2018). Sunda pangolin protection and trade-related crimes: Assessing local community knowledge in Kedah, Malaysia. *Journal of Sustainability Science and Management*, *13*(1), 169–180.

Baharuddin, Z. M., & Zuhairi, A. H. (2021). MOSS AS BIOINDICATORS FOR POLLUTION AT FRASER HILL AND CAMERON HIGHLAND PAHANG MALAYSIA. *PLANNING MALAYSIA*, *19*(16 SE-Article). https://doi.org/10.21837/pm.v19i16.969

Copper, B. K. (2007). Notes and comments "High and dry?" The Public Readiness and Emergency Preparedness Act and liability protection for pharmaceutical manufacturers. *Journal of Health Law*, *40*(1), 65–105.

CWE. (1989). *The Current Status of Wildlife Resources in China. Chin. Wildl. 3*, 3–4. (In Chinese)

Czech, B., Devers, P. K., & Krausman, P. R. (2001). The relationship of gender to species conservation attitudes. *Wildlife Society Bulletin*, 187–194.

Guzman, A., Heinen, J. T., & Sah, J. P. (2020). Evaluating the conservation attitudes, awareness and knowledge of residents towards Vieques National Wildlife Refuge, Puerto Rico. *Conservation & Society*, *18*(1), 13–24.

Harris, R. B. (2014). *Wildlife conservation in China: preserving the habitat of China's Wild West*. Routledge.

Hassan, Z. A., Schattner, P., & Mazza, D. (2006). Doing a pilot study: why is it essential? *Malaysian Family Physician: The Official Journal of the Academy of Family Physicians of Malaysia*, *1*(2–3), 70.

Huang, C., Wang, Y., Li, X., Ren, L., Zhao, J., Hu, Y., Zhang, L., Fan, G., Xu, J., & Gu, X. (2020). Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *The Lancet*, *395*(10223), 497–506.

Johanson, G. A., & Brooks, G. P. (2010). Initial scale development: sample size for pilot studies. *Educational and Psychological Measurement*, *70*(3), 394–400.

Keane, A., Jones, J. P. G., Edwards-Jones, G., & Milner-Gulland, E. J. (2008). The sleeping policeman: understanding issues of enforcement and compliance in conservation. *Animal Conservation*, *11*(2), 75–82.

Krejcie, R. V, & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement*, *30*(3), 607–610.

Li, P. J. (2007). Enforcing wildlife protection in China: the legislative and political solutions. *China Information*, *21*(1), 71–107.

McBeath, J. H. (2006). Biodiversity conservation in China: policies and practice. *Journal of International Wildlife Law and Policy*, *9*(4), 293–317.

National People's Congress. (2020). *Wild Animal Conservation Law of the People's Republic of China. Beijing.*

Peng, P. W. H., Ho, P.-L., & Hota, S. S. (2020). Outbreak of a new coronavirus: what anaesthetists should know. *British Journal of Anaesthesia*, *124*(5), 497–501.

Rosni, N. A., & Zainol, R. (2022). TRANSFORMATIVE IMPACT OF COVID 19 PANDEMIC ON THE URBAN PUBLIC SPACES. *PLANNING MALAYSIA*, *20*(24 SE-Article). https://doi.org/10.21837/pm.v20i24.1205

Siwen, Q. (2020). *[Special Report] "China has shown the world that the development trajectory of the epidemic can be changed" - Exclusive interview with Gao Li, WHO Representative in China. WHO Website.* https://news.un.org/zh/story/2020/03/1052882

Statistic Bureau of Wuhan. (2020). *Population of Wuhan*.

Wildaid. (2019). *Victory! CITES Approves Strong Protections for Pangolins. 25 Jun*. https://wildaid.org/victory-cites-approves-strong-protections-for-pangolins/

Worldometer. (2020). *Coronavirus Update (Live): 71,432,996 Cases and 1,601,088 Deaths from COVID-19 Virus Pandemic - Worldometer*. https://www.worldometers.info/coronavirus/?

WuHan.China. (2022). *Overview of Wuhan. Wuhan Municipal People's Government Website.* https://www.wuhan.gov.cn/zjwh/whgk/202004/t20200414_999422.shtml

Zhang, Hua, N., & Sun, S. (2008). Wildlife trade, consumption and conservation awareness in southwest China. *Biodiversity and Conservation*, *17*, 1493–1516.

Zhang, T., Wu, Q., & Zhang, Z. (2020). Probable Pangolin Origin of SARS-CoV-2 Associated with the COVID-19 Outbreak. *Current Biology*, *30*(7), 1346-1351.e2. https://doi.org/10.1016/j.cub.2020.03.022

Zhou, P., Yang, X.-L., Wang, X.-G., Hu, B., Zhang, L., Zhang, W., Si, H.-R., Zhu, Y., Li, B., & Huang, C.-L. (2020). A pneumonia outbreak associated with a new coronavirus of probable bat origin. *Nature*, *579*(7798), 270–273.

Received: 26th June 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 141 – 154

FACTORS INFLUENCING PRE- AND POST-COVID-19 TRANSPORT MODE SHIFT IN WORKPLACE TRAVEL

Noor Hashimah Hashim Lim[1], Bor Tsong Teh[2], Nik Hazwani Nik Hashim[3], Rama Krishna Supramanian [4], Urwatul Wusqa Baharudin[5], M. Rafee Majid[6]

[1,2,3,5,6]*Dept. of Urban and Regional Planning, Faculty of Built Environment,*
UNIVERSITI MALAYA
[4]*Dept. of Social and Preventative Medicine, Faculty of Medicine,*
UNIVERSITI MALAYA

Abstract

The current modal share between private and public transport in Malaysia still falls short of its 50:50 goal. The continued reliance on private transport for workplace travel faces further aggravation in light of the Covid-19 pandemic. Aiming to understand this concern, this study pursued two key objectives; (i) to explore shifts in transport mode choices before and after Covid-19; and (ii) to identify the significant factors influencing these shifts. This cross-sectional study was conducted in Kuala Lumpur, Malaysia, focusing specifically on workplace commuting (n=113). The McNemar's test was used to determine the significance of transport mode shifts from public to private transport and vice versa, while the Mann-Whitney U test was employed to determine the significance of various factors on these shifts. Four primary factors were examined: cost, accessibility, comfort, and hygiene concerns. The findings showed that (i) a discernible shift in transport modes occurred ($Q= 38.72$, $p>.05$), with a notable trend of individuals transitioning from public to private transport due to the Covid-19 pandemic; (ii) hygiene concerns (mean rank= 72.36, $U= 807.0$, $p<.000$) and comfort (mean rank= 64.73, $U= 1188.5$, $p= .013$) emerged as statistically significant influencers of this shift; and (iii) while cost (mean rank= 65.28, $U= 1053.5$, $p= .001$) is an important determinant of transport mode preferences, it was not found to be a significant factor driving mode shifts. A comprehensive examination of pandemic-induced transport mode preferences yields crucial insights for shaping transportation infrastructure and services, facilitating sustainable development in line with UN SDGs. Understanding these influences is vital for effective policy-making and achieving desired modal shares.

Keywords: Transport Mode Shift, Mode Choice, Modal Share, Modal Split, Covid-19

[1] Senior Lecturer at Universiti Malaya. Email: shimalim@um.edu.my

INTRODUCTION

The rate of urbanisation is intrinsically linked to the increase in population density per square kilometre (Deuskar, Baker & Mason, 2015). Consequently, heightened urban activities often lead to a rise in the demand for vehicular travel (Dulac, 2013). The 2018 Revision of the World Urbanization Prospects (United Nations, 2019) projected that cities worldwide will host an additional 2.5 billion inhabitants by the year 2050. This means that approximately 68% of the global population will identify as urbanites by that time. To put things into perspective, Southeast Asian nations alone are expected to surpass a total collective urban population of approximately 500 million by 2050 (United Nations, 2019), due to the consistent upward trajectory in urbanisation rates across the region in recent decades.

As demonstrated by reports indicating stable economic growth in middle-income developing Southeast Asian countries such as Malaysia (International Monetary Fund, 2018), the persistent shifts in demographic, migration and economic characteristics are inevitably influencing the patterns of vehicle travel, especially in the context of workplace mobility. Given that commuting between one's residence and workplace is an integral aspect of urban living, a deeper understanding of the factors that can encourage increased public transport utilisation for this purpose is highly necessitated.

The transportation infrastructure and service systems in Kuala Lumpur, Malaysia are undergoing continuous improvements to benefit its inhabitants (Hashim, 2021). Currently, it boasts the most extensive variety of transportation modes in comparison to other urban centres in the country, encompassing buses, taxis, e-hailing services, monorails, light rail transit, and commuter trains. Aligned with Malaysia's National Transportation Policy 2019 – 2030, increasing public transport modal share is one of the key benchmarks for achieving an improved transportation system for the country.

The motivation behind this study stems from the observation that while the Ministry of Transport Malaysia (2018) reported a concerning 79% reliance on private transport compared to a mere 21% utilisation of public transport prior to the onset of Covid-19, there was room for optimism when Bursa Malaysia (2020) noted a slow but promising pattern of increase in public transport utilisation from 2016 to 2018, as evidenced by daily average ridership figures for both rail and bus services. Although public transport utilisation only managed to capture a modal share of 21% in 2018 – considerably below the Ministry of Transport Malaysia's anticipated goal of 40% in 2020 – this slow but encouraging trend, especially for workplace commuting, faced unforeseen disruption with the event of Covid-19.

On this note, the evolving landscape of the working environment, with a notable shift towards remote work arrangements and a higher dependency on technological advancements (Lim, et al., 2022), may further change the travel behaviours of urban residents. Conversely, the prevalent reliance on private transport, despite the presence of well-established public transport infrastructure and services, raises significant concerns among government agencies. As such, it becomes imperative to understand the factors that either foster or hinder the inclination towards adopting public transportation as the primary mode of urban mobility and movement.

Furthermore, in alignment with the transport-related goals and targets outlined in the United Nations' Sustainable Development Goals (SDGs) of 2015, there is a call for countries to enhance urban accessibility through the development of sustainable infrastructure. This essentially entails providing urban inhabitants with improved transportation services that facilitates physical mobility between destinations. The associated SGDs also highlight the need of providing transportation infrastructure and services that are not only safe and affordable, but also readily accessible to the general populace, with special consideration for vulnerable and underserved segments of society, including women, children, the disabled, and the elderly.

To address and gain a better understanding of the aforementioned predicament, the study outlined two primary objectives; (i) to investigate whether a discernible shift in transport mode preference occurred for commuting to the workplace during two distinct time frames, i.e. pre- and post-Covid-19; as well as (ii) to examine whether there exists a significant disparity in the perceived importance of factors influencing transport mode choice between individuals who have undergone a mode shift, both in the pre- and post-Covid-19 periods. The study focused on four factors that were found to have significant impacts on an individual's choice of transport mode, namely cost, accessibility, comfort and hygiene concerns.

Cost consistently stands out as a major factor influencing the selection of transportation mode. While various studies have demonstrated that individuals of different gender, age groups and monthly household incomes may react differently to travel costs (Zyed et al., 2014; Mayo & Taboada, 2020), this does not negate the fact that financial considerations wield significant influence across most socio-demographic characteristics (Outwater et al., 2003). Typically, those opting for public transport tend to incur lower expenses compared to those who opt for private transport. Moreover, most individuals who opt for public transport often exhibit heightened concern and sensitivity towards travel costs (Ismail, et al., 2021). Consequently, the reduced cost of public transport becomes an enticing factor and a motivator for sustained utilisation (Maia, et al., 2020).

Accessibility to transport infrastructure and services is deemed a more important factor in the decision-making process regarding transport mode choice, surpassing the influence of the transport system's efficacy in providing access to one's desired destination (Brussel, et al., 2019). Supporting this, Lamanna, et al. (2020) found that limiting proximity to transit stops serves as a significant deterrent to increased public transport utilisation. Furthermore, the concept of ease of access to transportation features prominently among the many goals and targets outlined in the United Nations' SDGs. Studies have shown that heightened accessibility to one's preferred transport mode signifies an optimal level of transport equity (Martens, 2021).

The factor of travel comfort has demonstrated notable influence on transport mode choice (Shen, Chen, & Pan, 2016). In alignment with this observation, Masoumi (2019) found that individuals tend to lean towards private transport over public options, primarily due to the comfort level both modes offer. This is further substantiated by studies that highlight the discomfort in transport services provision can be a potential barrier to public transport usage, especially among the elderly (Lamanna, et al., 2020).

Hygiene concerns have surged to prominence in the wake of the Covid-19 pandemic. As articulated by Rankavat, et al (2023), the provision of hygiene features and a healthy awareness of hygiene concerns are now regarded as integral safety measures within transportation. The author further highlights that hygiene concerns emerge as a significant factor deterring individuals from opting for public transport, instead favouring private modes. This trend is hardly unexpected, given the growing apprehension and concerted precautions to mitigate the spread of Covid-19.

MATERIALS AND METHODS

Study Design

Employing a quantitative approach, this study aims to discern shifts in travelling mode choice before and after the Covid-19 pandemic. It specifically seeks to address two key questions: 'is there a shift in public transportation mode choice between the two periods?' and 'if so, what factor(s) influenced this shift?'. Kuala Lumpur, the capital city of Malaysia, was selected as the study locale due to several significant reasons: (i) it boasts the most variety and availability of both public and private transportation options and infrastructure compared to other regions of Malaysia, (ii) it exhibits the highest population density per square kilometre (iii) despite abundant access to public transportation services, there remains a strong dependency on private transportation, and (iv) income no longer serves as the primary indicator of transportation mode usage.

The combination of simple random sampling and stratified sampling techniques enabled the recruitment of a targeted population in an unbiased manner. The eligibility criteria for sampling is threefold, (i) adult Malaysians above the age of 18 years old who have resided and worked in Kuala Lumpur for a minimum of three years, (ii) able-bodied individuals, and (iii) those who commute to their workplaces. Respondents were stratified based on two criteria: race, i.e. Malay, Chinese, Indian and Others, and gender, i.e. Male and Female.

The required number of respondents per category based on this stratification mirrors the demographic distribution of Malaysia in 2022. With a 90% confidence interval level and considering a population size exceeding 100,000, the sampling size calculation according to Yamane (1967) required a minimum sample size of 100 for the study. Within a span of four months (June 2022 to September 2022), the study successfully recruited 113 eligible respondents who willingly participated in the study.

The data collection method applied was a face-to-face questionnaire survey, encompassing two sections featuring both close-ended and open-ended questions. Section A was designed to elicit respondents' demographic details as well as their preferred modes of transportation both before and after Covid-19, while Section B focused on assessing their perceptions on the factors influencing their post-Covid-19 transport mode choices. The bilingual questionnaires, presented in both English and Malay, were produced through a forward translation, which were subsequently reviewed by two bilingual experts using the conceptual equivalence method as recommended by the World Health Organisation Guidelines on Translation Instruments (2020).

Measures

Transport Mode Choice Pre- and Post Covid-19

The first objective of the study is to ascertain whether a shift in preferred transport mode for commuting to the workplace occurred, hence the measures of preferred transport mode choice before and after the Covid-19 pandemic are important variables of the study. Data were collected through two close-ended questions, (i) "What was your preferred mode of transportation to your workplace prior to the occurrence of Covid-19 pandemic?" and (ii) "What is your preferred mode of transportation to your workplace following the of Covid-19 pandemic?". Both questions offered respondents a similar range of responses, allowing them to choose between public transport options such as Light Rail Transit, Mass Rail Transit, KTM Komuter, Monorail, public buses, taxis, and e-hailing services; or private transport modes including cars and motorcycles. The collected responses were stored as nominal data.

Factors Influencing Transport Mode Choice

The second objective of the study aims to assess whether there exists a significant disparity in the perceived importance of factors influencing transport mode choice between individuals who have undergone a mode shift and those who have not, both before and after the Covid-19 pandemic. The study incorporates four key factors, namely cost, accessibility, comfort and hygienic concerns. These factors were evaluated on an ordinal scale via four close-ended questions where respondents were tasked with rating the importance of each factor specifically for commuting to the workplace, utilising a 4-point Likert scale where 1: Very not important, 2: Not important, 3: Important, and 4: Very important.

To deepen the understanding of the factors, respondents were also tasked with providing responses to six additional questions, each corresponding to a specific factor. For cost and hygiene concerns, respondents were prompted to rate their perception of their current transportation cost, and the level of hygienic measures associated with their current transport mode choice. Both questions employed a 4-point Likert scale, ranging from 1: Very low to 4: Very high. These responses were treated as ordinal data.

In addition to the aforementioned close-ended questions, the survey also included four open-ended questions. Respondents were prompted to state their average monthly transportation cost to their workplace in Ringgit Malaysia (RM), the average duration for the round-trip commute from their residences to their workplaces in minutes per day, and the distance between their residences and workplaces in kilometres (km). They were also encouraged to articulate the single most important hygienic feature that should be prioritised in any mode of transportation.

Demography

The study necessitates four key demographic details from respondents. This includes their age, gender, race, and average monthly household income in Ringgit Malaysia. These information are treated as control variables for the study.

Data Analysis

The data was recorded and analysed using IBM Statistical Package for Social Sciences (SPSS) version 29.0. The dataset was screened for missing values (n= 113) and unengaged responses. Four analytical methods were employed to conduct data analysis, with results interpreted at a 95% confidence interval level.

Firstly, descriptive analysis was employed to present the distribution of the collected data. Subsequently, the McNemar’s test was applied to assess the presence of a significant shift in mode choice for commuting to the workplace before and after the Covid-19 pandemic. In order to be able to perform a McNemar’s test, the dependent variable of the study must exhibit categorical and dichotomous characteristics. The pre- and post-Covid-19 transport mode choice data were therefore re-coded based on the occurrence of a transport mode shift. Instances where a transport mode shift occurred, in either direction, were re-coded as 1: Yes. Conversely, If the sample continued to utilise the same mode of transport, the individual was re-coded as 2: No. It is worth noting that the data is also mutually exclusive, signifying that the same individual who reported their transport mode choice before Covid-19 also provided their transport mode choice after Covid-19.

Thirdly, the study employed the Mann-Whitney U test to assess whether the four factors, namely cost, accessibility, comfort, and hygienic concerns, significantly influenced the shift in transport mode choice for workplace commuters before and after Covid-19. Lastly, as the study also collected written responses obtained through four open-ended questions, a thematic analysis was employed to identify recurring patterns in the provided answers, which were then organised into themes to provide a better understanding of the quantitative findings.

RESULTS

Univariate Analysis

Demography

The mean age of the respondents is 25.2 (±5) years. The distribution by gender showed a slightly higher percentage of male respondents (52%) over females (48%). In terms of race, the respondent demographics mirror that of the broader Malaysian population, where 58% are Malay, 21% are Chinese, 20% are Indians and 1% are from Other ethnic backgrounds. A significant majority of respondents belong to the lower-income bracket, earning an average of less than RM4,850 on a monthly basis (72%), while the remaining 28% fall into the medium-income category, with earnings between RM4,851 to RM10,970. Notably, none of the respondents are from the higher-income level, earning in excess of RM10,971.

Transport Mode Choice Pre- and Post Covid-19

Examining the transport mode choices during the pre-Covid-19 period reveals that 78% of respondents relied on public transportation for their daily commute to work, while only 22% opted for private transportation. In contrast, the transport mode choice post-Covid-19 exemplified a notable shift, with 61% of respondents favouring private transportation over public options (39%). The demographic distribution and corresponding transport mode choices before and after Covid-19 are presented in **Table 1.**

Factors influencing Transport Mode Choice

The perceived factors influencing transport mode choice is shown in **Table 1**. Cost is deemed an important factor in the selection of transport mode for commuting to the workplace, with 42% considering it very important and 30% deeming it important. Conversely, a mere 28% found it not and very not important. A large majority of respondents (69%) perceived the cost of their chosen transport mode for post-Covid-19 workplace commuting as ranging from high to very high. The remaining 31% regarded transportation costs as ranging from low to very low. The analysis of open-ended question revealed that the average monthly transportation cost to work is approximately RM280. Notably, a large majority of respondents reported transportation costs to the workplace below RM400.

Table 1. The distribution of the respondents' demography and transport mode choice during two distinct time periods; pre- and post-Covid-19 (n= 113)

	Overall, *100%*
Age, *SD*	25.2 (±5)
Gender, *%*	
Male	52
Female	48
Race, *%*	
Malay	58
Chinese	21
Indian	20
Others	1
Education level, *%*	
Without tertiary education	27
With tertiary education	73
Monthly household income, *%*	
≤ RM4,850	72
RM4,851 – RM10,970	28
≥ RM10,971	-
Transport mode choice pre-Covid-19, *%*	
Public Transport	78
Private Transport	22
Transport mode choice post-Covid-19, *%*	
Public Transport	39
Private Transport	61
Transport mode shift, *%*	
Public Transport to Private Transport	42
Private Transport to Public Transport	2
Public Transport to Public Transport	19
Private Transport to Private Transport	37

In terms of accessibility, a majority identified it as an important (59%) or very important (25%) factor influencing their choice of transport mode for commuting to work. The remaining 16% considered the accessibility of their chosen transport mode to work as ranging from low to very low. On average, respondents reported a daily round-trip travel time of approximately 40 minutes between their residences and workplaces, covering an average distance of roughly 20 kilometres (one-way). Comfort emerged as a key consideration, with 51% deeming it important and 38% rating it as a very important factor in their choice of transport mode. A minority of 11% reported that comfort was not an important factor in their daily commute choice. Similarly, most also felt the same way about the hygiene of their chosen mode of transport, with 58% considering it very important and 38% deeming it important. Only a small fraction of 4% stated that hygiene was not an important factor during their work travels. When asked about the level of hygienic features available or precautions taken around their chosen transport mode, the majority of respondents perceived it to range from high (57%) to very high (40%). A mere 3% expressed dissatisfaction with the level of hygiene maintenance in their chosen mode of transport.

Bivariate Analysis

Transport Mode Shift Pre- and Post Covid-19

In order to identify any descriptive shifts in transport mode choice before and after Covid-19 for workplace commuting, the dataset was assessed and re-coded into 1: Shift from public transport to private transport (PT to PV), 2: Shift from private transport to public transport (PV to PT), 3: Remained with private transport (PV to PV), and 4: Remained with public transport (PT to PT). The re-coding revealed that 42% of respondents shifted from public transport to private transport. This is closely followed by 37% of respondents who remained using private transport for their work commute both pre- and post-Covid-19. Nineteen percent maintained their use of public transport during both periods. Lastly, the remaining 2% shifted from private to public transport within the same timeframe.

Next, the study conducted the McNemar's test to establish the statistical significance of the shift in transport mode choice before and after Covid-19 (refer Table 2). The null hypothesis posits that there is no significant shift in transport mode choice for workplace commuting over the two time periods. The obtained Q value is 38.72. As the study employs the 95% confidence interval level, with reference to the critical points for chi-square distribution, the value for 0.05 is 3.84. Given that the value of 38.72 exceeds 3.84, the null hypothesis is rejected. This implies that, statistically, there is a significant shift of transport mode choice before and after Covid-19, occurring in both directions, i.e. from public to private transport and vice versa.

The perceived difference of factors influencing transport mode choice

The subsequent phase of the analysis aims to discern whether there exists a disparity in the perceived importance of factors influencing transport mode choice among respondents who have shifted their mode of transport and those who have not, both before and after Covid-19 (refer **Table 2**). To facilitate this, the Mann-Whitney U test is conducted with a pre-requisite of data re-coding. The transport mode choices of respondents before and after Covid-19 are transformed into dichotomous variables, denoted as 1: Shift and 2: No shift. Descriptively, it is evident that 56% of respondents maintained their original transport mode choice over the two periods, while the remaining 44% opted to shift their mode of transport during the same timeframe.

For respondents who maintained their transport modes throughout both pre- and post-Covid-19 periods, the factor of cost (mean rank= 65.28, U= 1053.5, p= .001) emerges as a statistically significant influence on their transport mode choice. On the other hand, among respondents who did shift their transport modes during these periods, comfort (mean rank= 64.73, U= 1188.5, p= .013) and hygiene concerns (mean rank= 72.36, U= 807.0, p<.000) were found to be statistically significant factors. Finally, although accessibility (mean rank= 60.10, U= 1380.0, p= .200) is more important for those who did not shift their transport modes, this output did not reach statistical significance.

Table 2. Distribution of the respondents' perceived importance of factors influencing transport mode choice pre- and post-Covid-19 on a 4-point Likert scale (n= 113)

Factors influencing transport mode choice	Perceived importance of respective factors				Mean rank	Statistical difference
	Very not important, %	Not important, %	Important, %	Very important, %		Mann-Whitney U (*p*-value)
Cost, %	2	26	30	42		
Shift					46.57	1053.5**
No shift					65.28	(.001)
Accessibility, %	-	16	59	25		
Shift					53.10	1380.0
No shift					60.10	(.200)
Comfortability, %	-	11	51	38		
Shift					64.73	1188.5
No shift					50.87	(.013)**
Hygiene concerns, %	-	4	38	58		
Shift					72.36	807.0
No shift					44.81	(<.000)***

*p < 0.05, **p < 0.01, ***p < 0.00

DISCUSSION

The study began with the objectives of investigating transport mode shifts for workplace commuting, both pre- and post-Covid-19, as well as examining the perceived importance of factors influencing transport mode choice in these two distinct periods. This cross-sectional study, incorporating the four study factors of cost, accessibility, comfort, and hygiene, yielded several important insights that helped shed light in understanding the predicament. Empirical evidence underscores the substantial impact of Covid-19 on the behaviours of transport users, specifically for workplace commuting.

The significant shift in transport mode choice pre- and post-Covid-19 is apparent, as individuals predominantly using public transport displayed a pattern of shifting and increasing their reliance on private transport after the Covid-19 pandemic. This further underscores the pandemic's disruptive influence on modal share. Notably, individuals predominantly using private transport pre-Covid-19 largely persisted with this choice post-Covid-19. These findings align with prior studies on transport mode shifts (Purwoko & Yola, 2022) attributed to Covid-19 (Vega-Gonzalo, Gomez & Christidis, 2023).

Hygiene concerns emerged as the paramount determinant influencing an individual's daily commute choice, understandably so given the critical health implications associated with Covid-19. For those who shifted their mode of transport during the two timelines of pre-and post-Covid-19, hygiene and comfort were identified as pivotal factors. While hygiene and health are regarded as important determinants influencing transport mode choice, cost is ranked the second most important factor.

Based on the report published by the Institute of Strategic and International Studies, Malaysia (Cheng, 2020), the Covid-19 pandemic exerted substantial strain on the Malaysian economy, leading to increased unemployment. With the retraction of monthly household income and possible disposable income among Malaysian families, this economic impact naturally elevated concerns about transportation costs. This explains why cost is a significant retaining factor for those who maintained their mode of transport pre- and post-Covid-19. In other words, although cost is an important factor in influencing mode choice, it was not the primary driver for shifts in transport modes both before and after Covid-19, specifically for workplace commuting.

Understanding the factors that influence transport mode choice and the shift in transport mode choice due to a pandemic offers insight to "choice behaviours" regarding transportation infrastructure and services (Yang, et al., 2022). This lays a foundation of shaping the development and advancement of sustainable transportation policies (Ghazali, et al., 2021) as outlined by the United Nations SDGs goals and targets.

CONCLUSION

The impact of cost on mode choice remains significant in determining transportation usage, yet it does not serve as the primary driver behind the observed shifts in transport mode selection during pre- and post-Covid-19, particularly for commuting to workplaces. While cost continues to be a crucial factor, the transformation in mode preferences can be largely attributed to a combination of factors. These include the growing emphasis on health and safety, with commuters prioritising modes that offer lower exposure to potential risks, such as crowded public transport. Supporting this, the study provides evidence that hygiene concerns and comfort while travelling to workplaces are statistically significant in influencing transport mode shift due to the Covid-19 pandemic.

A limitation of the study is that it does not capture data on the specific mode of transportation used for work travel pre- and post-Covid-19. Future studies are highly recommended to explore how these factors differ across various modes of transportation. Additionally, the rise of remote work arrangements has altered traditional commuting patterns, leading to a re-evaluation of transportation needs and preferences, where factors such as convenience, flexibility, and personal well-being now hold heightened significance in the decision-making process. Navigating this evolving landscape requires a nuanced understanding of the complex interplay of these multiple influences, which is imperative for devising effective and sustainable transportation policies, especially in achieving the desired modal share within the stipulated timeline.

REFERENCES

Brussel, M., Zuidgeest, M., Pfeffer, K., & Van Maarseveen, M. (2019). Access or accessibility? A critique of the urban transport SDG indicator. *ISPRS International Journal of Geo-Information*, *8*(2), 67.

Bursa Malaysia (2020). Malaysia’s Public Transportation Sector & Reviving Malaysia’s Infrastructure Privatisation. https://www.bursamalaysia.com/sites/5d809dcf39fba22790cad230/assets/5f17bda439fba224819e094d/Session_1_IMKL2020_V2.pdf

Cheng, C. (2020). *COVID-19 in Malaysia: Economic impacts & fiscal responses*. Institute of Strategic and International Studies, Malaysia.

Deuskar, C., Baker, J. L., & Mason, D. (2015). *East Asia's changing urban landscape: Measuring a decade of spatial growth*. World Bank Publications.

Dulac, J. (2013). Global land transport infrastructure requirements. *Paris: International Energy Agency*, *20*, 2014.

Ghazali, W. N. W. W., Ponrahono, Z., Bachok, S., Sharaai, A. H., Rabe, N. S., Shukri, N. S. M., & Sunoto, Y. N. (2021). Travel Mode Choice Intention in Reducing Traffic Congestion in Kajang, Selangor. *Planning Malaysia*, *19*.

Hashim, N.H.N. (2021). *A Framework for Sustainable Urban Regeneration (SUR) in Historical Inner Cities: The Case of KL Sentral*. Unpublished PhD Thesis, University of Malaya, Kuala Lumpur, Malaysia.

International Monetary Fund (2018). *Malaysia: 2018 Article IV Consultation-Press Release; Staff Report; and Statement by the Executive Director for Malaysia.* Series: Country Report No. 2018/061. https://www.imf.org/en/Publications/CR/Issues/2018/03/07/Malaysia-2018-Article-IV-Consultation-Press-Release-Staff-Report-and-Statement-by-the-45677

Ismail, N. A. F. B., Ismail, N. A. I. B., Faizal, N. I. F. B. M., Ijama, N. R. A. A. B., Suzeli, N. A. B., Ezam, N. A. B. A., ... & Krishnan, I. A. (2021). User Satisfaction of the

Free Shuttle Bus Service in Petaling Jaya. *Malaysian Journal of Social Sciences and Humanities (MJSSH)*, *6*(11), 427-441.

Lamanna, M., Klinger, C. A., Liu, A., & Mirza, R. M. (2020). The association between public transportation and social isolation in older adults: A scoping review of the literature. *Canadian journal on aging/La Revue canadienne du vieillissement*, *39*(3), 393-405.

Lim, N. H. H., Majid, M. R., Zainol, R., & Teh, B. T. (2022). Pathways of Neighbourhood Obesogenic Environment During Covid-19: Impacts and Way Forward. *Planning Malaysia*, 20.

Maia, A. G., Carvalho, C. S. D., Venâncio, L. C., & Dini, E. D. (2020). The Motives Behind Transport Mode Choice: A Study with University Students in Brazil. *Ambiente & Sociedade*, *23*.

Martens, K. (2021). Equity considerations in transportation planning. *(Ed.), Encyclopedia of transportation*, *6*, 154-160.

Masoumi, H. E. (2019). A discrete choice analysis of transport mode choice causality and perceived barriers of sustainable mobility in the MENA region. *Transport policy*, *79*, 37-53.

Mayo, F. L., & Taboada, E. B. (2020). Ranking factors affecting public transport mode choice of commuters in an urban city of a developing country using analytic hierarchy process: The case of Metro Cebu, Philippines. *Transportation Research Interdisciplinary Perspectives*, *4*, 100078.

Ministry of Transport, Malaysia. (2019). National Transport Policy 2019-2030. https://www.pmo.gov.my/2019/10/national-transport-policy-2019-2030/

Outwater, M. L., Castleberry, S., Shiftan, Y., Ben-Akiva, M., Shuang Zhou, Y., & Kuppam, A. (2003). Attitudinal Market Segmentation Approach to Mode Choice and Ridership Forecasting: Structural Equation Modeling. *Transportation Research Record*, *1854*(1), 32–42.

Purwoko, B. A., & Yola, L. (2022). Willingness to modal shift from private to public transportation in Jakarta metropolitan area. *Planning Malaysia*, *20*.

Rankavat, S., Gurram, A. R., Pawar, D. S., & Kushwaha, V. (2023). Study of COVID-19 impact on users' perception for transport modes choice in India. *Iatss Research*, *47*(1), 73-83.

Shen, Q., Chen, P., & Pan, H. (2016). Factors affecting car ownership and mode choice in rail transit-supported suburbs of a large Chinese city. *Transportation Research Part A: Policy and Practice*, *94*, 31-44.

United Nations, Department of Economic and Social Affairs, Population Division (2019). *World Urbanization Prospects: The 2018 Revision (ST/ESA/SER. A/420).* New York: United Nations.

Vega-Gonzalo, M., Gomez, J., & Christidis, P. (2023). How has COVID-19 changed private car use in European urban areas? An analysis of the effect of socio-economic characteristics and mobility habits. *Transportation research part A: policy and practice*, *172*, 103679.

World Health Organisation Guidelines on Translation Instruments (2020). https://cdn.who.int/media/docs/default-source/publishing-policies/whoqol-100-guidelines/translation-methodology.pdf?sfvrsn=74cdb8f5_2

Yang, Y., Han, X., Jiang, R., Jia, B., & Gao, Z. Y. (2022). Competition and coordination in public transport: A mode choice experiment. *Transportation Research Part C: Emerging Technologies*, *143*, 103858.

Zyed, Z. A. S., Wan Abd Aziz, W. N. A., Hanif, N. R., & Tedong, P. A. (2014). Affordable Housing Schemes: Overcoming Homeownership Problems. *Open House International*, *39*(4), 5–13.

Received: 7th June 2023. Accepted: 5th September 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 155 – 172

THE EFFECTS OF LOW CARBON CITIES FRAMEWORK CHECKLIST (LCCFC) IMPLEMENTATION ON COMMUNITY SATISFACTION LEVEL

Siti Kartina Juhari[1], Dasimah Omar[2], Siti Mazwin Kamaruddin[3] Noraini Omar Chong[4]

[1,2,3,4] *Kolej Pengajian Alam Bina,*
UNIVERSITI TEKNOLOGI MARA

Abstract

Local authorities (LA) have been serving as leaders in their communities to implement the Low Carbon Cities Framework (LCCF). LCCFC, although carefully developed, has not been effectively utilised. This paper aimed to study the effect of LCCFC implementation on community satisfaction levels. The objectives of this paper were: (i) to determine the implementation of LCCFC in relation to community satisfaction, (ii) to analyse the levels of community satisfaction across economic, social, and environmental aspects, and (iii) to suggest strategies and frameworks for enhancing community satisfaction. A mixed method approach was employed, which encompassed both an interview and a questionnaire survey. The questionnaire survey reached a sample size of 400 participants, drawn from six distinct neighbourhood areas within the jurisdiction of the Subang Jaya Municipal Council. Meanwhile, the interview was conducted with town planners within a Local Authority (LA) as key stakeholders, alongside the community. The qualitative data was analysed using Atlas Ti, while the quantitative data was via SPSS. The findings of the present study reveal that the utilisation of the LCCF checklist by the local authority concerned is currently inadequate, thereby necessitating the identification of strategies for improvement and the formulation of action plans to enhance community contentment. It is recommended that the findings of the current study be utilised as a point of reference by other local authorities, thereby constituting a significant advancement in the pursuit of accelerating sustainable development.

Keywords: Low Carbon Cities (LCC), Low Carbon Cities Framework (LCCF) Checklist, Community Satisfaction, local authority

[1] Senior Lecturer at Universiti Teknologi MARA. Email: kartinajuhari@uitm.edu.my

INTRODUCTION

Cities have a significant impact on the past, present, and future. While urban development has positive aspects, it can also result in urban degradation (Shepherd et al., 2016; Copelliti et al., 2018), which is resulting from the people's carbon footprint (Jones et al., 2018), that is characterised by environmental, social, and economic problems. For example, Bateman (2017), in his study, reveals the deteriorating state of the world because of global warming and the observed rate of temperature rise over time.

Nevertheless, the international system of environmental management focusing on lifestyles and industrialisation is moving slowly in the right direction (Ho Chin Siong, 2015). According to the United Nations (2020), environmental problems have been recognised and acknowledged at the United Nations Conference on the Environment and Development (UNCED) held in Rio de Janeiro in 1992 (UNCED, 1992). This recognition resulted in the adoption of Agenda 21 implementation which was accepted by 178 governments in 1992. However, the United Nations Environment culminated with the World Summit on Sustainable Development (WSSD) into a sustainable development framework (Panels et al., 2020). Sustainable models have also been developed to support this movement. This includes the model by William McDonough (2010), which presented the concept of cradle to grave as a perspective within the environmental approach (Khan, 2020), denoting the environment as the start and the end of life (Siti Kartina; 2021, Baumgart, 2020).

The increasing importance of sustainable development shifts the focus on its impact on a city's economy, environment, and society. One example is the Low Carbon Cities Framework (LCCF), which has been implemented in cities aimed at achieving green city status by enhancing sustainable developments (Hunter et al., 2019). To deal with urban degradation, Malaysia applies LCCF to reduce carbon emissions while simultaneously benefiting from its tremendous economic opportunities (Lee, 2019). According to Malaysia's Ministry of Energy (2017), the implementation of LCCF covers four (4) main areas: urban environment, urban infrastructure, urban transportation, and buildings, as guidance to local authorities. The LCCF Checklist (LCCFC), applied in the planning permission process (Juhari et al., 2018), sets the minimum requirement and passing score to assess the readiness of a particular project.

The current study discovered gaps in the readiness for the implementation of LCCF at the local authority level in Malaysia. Thus, the objective of this paper was (i) to determine the implementation of LCCFC in community satisfaction, (ii) to analyse the unity satisfaction in the economic, social, and environmental aspects, and (iii) to suggest strategies and frameworks.

LITERATURE REVIEW

Low Carbon Cities (LCC)

Low Carbon Cities (LCC) are generally defined as cities comprising communities that utilise sustainable green technologies, employ green practices, and emit relatively low carbon compared to current practices to avoid adverse effects of climate change (KeTTHA, 2017). According to Hunter et al. (2019), China is the recent LCC with a sustainable urbanism plan to respond to the impacts of climate change. Though LCCs have been implemented globally, they are referred to by slightly different names depending on the province, city, municipality, or community that pursues a systematic process to achieve carbon emission reductions (Siti Kartina, 2021; D.O., 2019).

Low Carbon Cities Framework (LCCF)

Low Carbon Cities Framework (LCCF) (KeTTHA, 2017; 2011) is a performance-based framework that captures the actual environmental impact of development in terms of total carbon emission. The framework provides information on carbon equivalent due to human activities in cities in order to increase public awareness of reducing low carbon emission levels. LCCF and the assessment system, LCCF Track, are developed and managed by GreenTech Malaysia (2017). On the other hand, the LCCF Checklist is an online carbon assessment designed to support the implementation of LCCF by assessing the performance criteria and the planning permission.

Low Carbon Cities Framework Checklist (LCCFC)

The LCCFC is based on four (4) main areas: urban environment, urban infrastructure, urban transportation, and buildings (see Table 1). It is a tool for planning permission in development control and serves as a guide to the local authorities. It includes a list of requirements required to be qualified as a Low Carbon Project (Ministry of Energy, 2017). LCCFC is divided into two approaches: (i) city-based (mitigating all LCCF criteria) and (ii) one-system (mitigating one or some LCCF criteria).

Table 1: The Element and Score for LCCFC

Elements			
Urban Environment (UE)	Urban Transportation (UT)	Urban Infrastructure (UI)	Building (B)
Score For LCCFC			
% Score		LCCFC Achievement	
> 90		Outstanding	
80 – 89		Excellent	
70 – 79		Very Good	
60 – 69		Good	
50 – 59		Poor	

Elements			
Urban Environment (UE)	Urban Transportation (UT)	Urban Infrastructure (UI)	Building (B)
< 49		Unclassified	

Source: Adapted from the Ministry of Energy, Green. Technology and Water (KeTTHA, 2017)

Readiness to Implement Low Carbon Cities Framework Checklist (LCCFC)
Results on the community's satisfaction enable this paper to assess the readiness of the LA officers in implementing the LCCFC. LCCFC applications within the Planning Permission Authority focused on input from experienced LA Officers. It also only investigated the interactions between the community within the implementation of LCCFC development projects of the local authority. The preceding research confirms that implementing the LCCFC's concept in development control affects the community through which its implementation can satisfy the community's needs. For example, there was no covered pedestrian walkway connecting the public transportation LRT station.

LCCFC and Planning Permission in Development Control for Strategy Rating Tool
Development control regulates land and buildings by the local planning authority; meanwhile, land-use planning is regulated by the Town and Country Planning as stated in Act 1976 (Act 172). In Act 1976, 2(1) defined developments as (a) carrying out building work*,* including demolition, erection, re-establishing or expanding a building or part thereof, (b) carrying out engineering work such as shaping and levelling, alignment of access, cable alignment, and access to the water, (c) carrying out the mining and industrial work, (d) making a material change in use of land or buildings or any part thereof, and (e) breaking boundaries and mix the soil (PLANMalaysia, 2021).

The vital role of the local authorities lies in regulating land planning and exercising development control, as highlighted by Abdullah et al., (2011) who emphasise empowering local authorities' power and responsibility. These responsibilities consist of regulating land use and promoting more desirable social and environmental planning towards sustainable development. Thereby, land-use planning may include efforts to conserve the environment, restrain urban sprawl, minimise transportation costs, prevent land-use conflicts, and reduce exposure to pollutants. By and large, land uses determine the diverse socio-economic activities that occur in a specific area, the patterns of human behaviour they produce, and their impact on the environment.

Sustainable aspect
According to Mensah (2019), people want to live now and in the future in sustainable cities. These cities must meet the diverse needs of existing and future populations, be sensitive to their environment, and ensure that their lifestyle and consumption do not adversely affect the environment. At the same time, it also preserves the natural environment and simultaneously contributes to a high quality of life. Therefore, sustainable cities are safe, inclusive, and good as well as well-planned, build, manage, and offer equal opportunities and urban services for all (Caprotti et al., 2018). The sustainable city elements address three tenets of sustainable development, namely economic, social, and environmental.

Economic aspect
Economic outcomes determine the economic aspect of community satisfaction. Economic sustainability is the decisions that are made in the most equitable and fiscally sound way possible while considering the other aspects of sustainability. It involves creating economic value out of whatever project or decision is undertaken. Economic sustainability

Social aspect
The social aspect of community satisfaction is an achievement in sustainability based on the concept that a decision or project promotes community betterment. The social aspects also evaluate community satisfaction in the implementation of LCCFC in the planning permission project, for example, is that the LCCFC can provide cost reductions, such as a bicycle lane, public transportation via bus and pedestrian walkway.

Environmental aspect
The environmental aspect of community satisfaction promotes equilibrium within the natural systems and seeks to encourage growth. It is also sustainable that an ecosystem would maintain populations, biodiversity, and overall functionality (Christopher Wanamcaker, 2020).

Community participation and reception in LCCFC implementation
A community refers to people who share interests grouped in a neighbourhood. In the LCCFC, the community serves as a fundamental principle, aligned with the Local Agenda 21 of SDG (Worlds Health Organization, 2016). Community participation entails people participating in a collaborative creative effort, invention, and planning in areas where development can be accomplished. The definition of a community used to measure sustainable development to evaluate community satisfaction and reception is gauged in the quantitative approach

(Noori, 2017), whereby community satisfaction is realised through community involvement in implementing LCCFC in a local authority.

Performance Criteria

The four elements of LCCF can be further categorised into fifteen (15) performance criteria and 41 sub-criteria, each providing specific intent towards carbon reduction targets (Ministry of Energy, 2017). In this paper, LCCF performance criteria to gauge respondents' agreement towards its implementation in planning permission project development from the developer. The element, score, performance criteria, and sub-criteria of LCCF are listed in Table 2.

Table 2: Element, Score, Performance Criteria, and Sub-Criteria of LCCF

Element	Performance Criteria	Score (105)	Performance Criteria	Sub-Criteria
Urban Environment (UE)	● UE 1: Site Selection	10	3 Performance Criteria	14 Sub-Criteria
	● UE 2: Urban Form	18		
	● UE 3: Urban Greenery and Environmental Quality	9		
	Total Criteria Achieved for UE	37		
Urban Transportation (UT)	● UT 1: Reduction Use of Private Motorised Transport on Urban Road Network	8	6 Performance Criteria	11 Sub-Criteria
	● UT 2: Increase in Public Transport	5		
	● UT 3: Mode Shift from Private to Public Transport and Non-Motorised Transport	5		
	● UT 4: Use of Low Carbon Transport	4		
	● UT 5: Improvement to Level of Service of Road Links and Junctions	2		
	● UT 6: Utilisation of Transit-Oriented-Development (TOD) Approach	5		
	Total Criteria Achieved for UT	29		
Urban Infrastructure (UI)	● UI 1: Infrastructure Provision	9	4 Performance Criteria	10 Sub-Criteria
	● UI 2: Waste	10		
	● UI 3: Energy	3		
	● UI 4: Water Management	4		
	● *Total Criteria Achieved for UI*	*26*		
Building (B)	● B 1: Sustainable Energy Management System	3	2 Performance Criteria	6 Sub-Criteria
	● B 2: Low Carbon Buildings	10		
	Total Criteria Achieved for UB	13		

Source: Ministry of Energy, Green. Technology and Water (KeTTHA), 2017

The selected performance criteria are based LCCFC list. The current paper selected ten (10) items that involved (i) a comprehensive pedestrian network, (ii) a comprehensive cycling network, (iii) green open space, (iv) the number of trees or community gardening, (v) public transport ridership, (vi) use of more fuel-efficient vehicles for passenger vehicles and green freight transport, (vii) a number of charging stations, (viii) new development and redevelopment schemes incorporating tod concept, (ix) walking and cycling facilities to support access and mobility to/from public transit nodes, and (x) household solid waste management.

RESEARCH METHODOLOGY

The current study employed a case study to focus on the area that implemented LCCFC and planning permission. The methodology employed was a mixed method. The qualitative research involved face-to-face interviews with experts, the local authority (LA) officers. Meanwhile, 400 respondents, from six (6) neighbourhoods in Subang Jaya Municipal Council jurisdiction, namely: (i) BPK1.1: USJ-Sunway, (ii) BPK 1.2: USJ-Subang Jaya, (iii) BPK 3.1: Putra Heights, (iv) BPK 5.1: Bandar Puteri, (v) BPK 5.2 Puchong Perdana, and (vi) BPK 6.1: Taman Equine were involved in the study's quantitative research by answering a questionnaire survey forms.

The conceptual framework provided detailed information on the relationship between each variable. Conceptual is a variable that will be known as a concept, as shown in Figure 1. Elements are not included in the conceptual framework because elements were included in the questionnaire question. Conceptual is formed for the actual explanation of how the assessment is made according to the aspect of economic, social, and environmental. The data analysis discussed in the implementation of LCCFC was assessed from the perspective of the LA officers and community reception. The levels of community satisfaction were determined by a survey on the use of the LCCFC in development control. The outline illustrated the effect of LCCFC implementation in the local authority, which should reflect the LA officers' readiness to apply the LCCFC (Juhari et al., 2018). Thus, the result of the current study reflected the readiness of implementation in LCCFC in a local authority and suggested improvement of strategies and action plans that were aligned with communities' satisfaction.

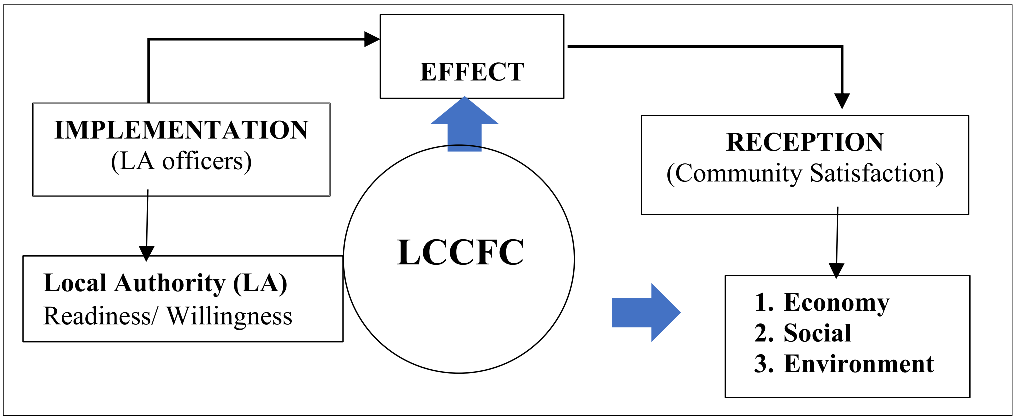


Figure 1: Conceptual framework

ANALYSIS AND FINDINGS

The current paper studied ten (10) performance criteria and the readiness levels of LCCF implementation among developers. The study also investigated the achievement of LCCF from the aspects of economic, social, and environmental in sustainable development by measuring the community's satisfaction level.

From the Levene test schedule (see Table 2), the variable with Homogeneity of Variances (p>.05) was identified, allowing the variable data and groups to be tested with ANOVA. Therefore, the conditions of uniformity were met.

Table 3: Test of Homogeneity of Variances

Item	Levene Statistic	df1	df2	Sig.
SUM_ECON	7.005	5	394	.000
SUM_SOCIAL	6.853	5	394	.000
SUM_ENVI	4.045	5	394	.001

Table 3 displays the SS (Sum of Squares) values between aspects with F=10.816, indicating that the min score for the planning block group was significantly different. According to the planning block sampling area, the results revealed that respondents saw no substantial difference in cost savings by using the pedestrian walkway as the F-test value was highest in the economic aspect rather than the social and environmental aspects.

Table 4: Result of ANOVA Effect in LCCFC

		Sum of Squares	df	Mean Square	*F*	Sig.
SUM_ECON	Between Groups	58.106	5	11.621	10.816	.000
	Within Groups	423.331	394	1.074		
	Total	481.437	399			
SUM_SOCIAL	Between Groups	60.992	5	12.198	3.202	.008
	Within Groups	1501.105	394	3.810		
	Total	1562.098	399			
SUM_ENVI	Between Groups	92.329	5	18.466	9.394	.000
	Within Groups	774.511	394	1.966		
	Total	866.840	399			

Economy

The economic characteristic of sustainable development primarily concerns the cost-value trajectory that contributes to saving money, such as the expansion of public transportation or the installation of bicycle lanes to promote its usage. Apart from that, these amenities will also benefit the community at large.

ANOVA was used to determine whether there were any significant differences between the mean values of the three independent groups relating to the economic aspects. It distinguished the mean value of respondents within the small planning block sample and compared the community's satisfaction value with LCC implementation.

Table 5: The Analysis of Economic Aspect

Group	*n*	Mean	SD	*F*	*p*
BPK 1.1	141	9.3901	.74425	10.816	0.00
BPK 1.2	44	9.1364	.82380		
BPK 3.1	23	8.8696	1.01374		
BPK 5.1	62	8.6452	1.47211		
BPK 5.2	85	8.4824	.90779		
BPK 6.1	45	8.6222	1.45053		
Total	400	8.9375	1.09846		

Environment

The introduction of the LCCFC could reduce carbon footprint as it effectively eliminates vehicular dependency. Thus, one of the drives towards this change is by planning authorities providing bicycle lanes with material green infrastructure.

The Levene test schedule shows the variable had a Homogeneity of Variances (p>.05), allowing the variable data and groups to be tested with

ANOVA (refer to Table 6). Therefore, the conditions of uniformity were met. The ANOVA table displays the SS value between aspects with a value of *F*=9.394, indicating the min score of the planning block group was significantly different.

Table 6: The Analysis of the Environmental Aspect

Group	*n*	Mean	SD	*F*	*p*
BPK 1.1	141	13.2482	1.08993	9.394	0.00
BPK 1.2	44	12.9318	1.14927		
BPK 3.1	23	13.0435	.97600		
BPK 5.1	62	12.0000	1.78335		
BPK 5.2	85	12.4941	1.40258		
BPK 6.1	45	12.2000	1.97254		
Total	400	12.7300	1.47395		

Social

The pedestrian walkways could modify behaviour by enhancing social contact in the community, making LCCFC an added attraction. The walkway could result in shared enjoyment in the neighbourhood area. For example, it can strengthen the mutual interaction of neighbours. Besides, the implementation of the LCCFC could promote a healthier lifestyle as it encourages physical exercises from using the pathways through activities such as walking on the pedestrian path to the LRT Station, as illustrated in Plate 1.

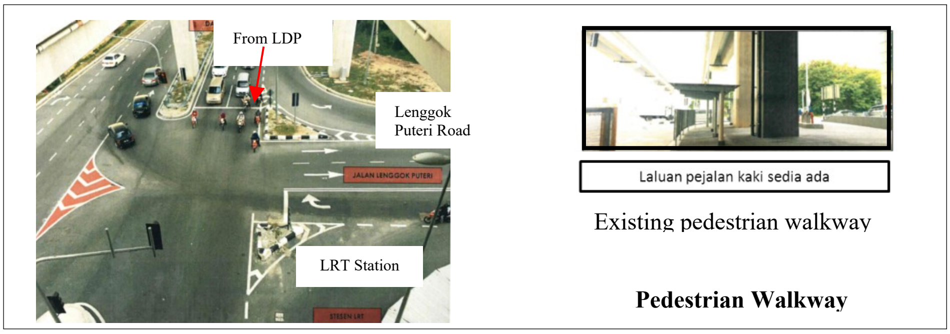


Plate 1: Pedestrian Walkway Facilities at the LRT Station
Source: Briefing on Guidelines Criteria Plot ratio and density for the application of planning permission in Subang Jaya Municipal Council, 2018

Table 7: The Analysis of Social Aspect

Group	*n*	Mean	SD	*F*	*p*
BPK 1.1	141	18.8936	1.08993	3.202	.008
BPK 1.2	44	19.1136	1.14927		
BPK 3.1	23	19.3478	.97600		
BPK 5.1	62	18.0968	1.78335		
BPK 5.2	85	18.6118	1.40258		
BPK 6.1	45	18.1111	1.97254		
Total	400	18.6725	1.47395		

Table 7 shows the variable had a Homogeneity of Variances (p>.05), thereby allowing variable data and groups to be tested with ANOVA. Therefore, the conditions of uniformity were met. The ANOVA table describes the SS (Sum of Squares) value between aspects with a value of F=3.202, indicating that the min score of the planning block group was significantly different.

The Community Satisfaction on Implementation LCCFC

The perception of the respondents on the implementation of LCCFC was discussed. The Likert scale survey question was used to gauge the results. According to Chomeya (2010), the use of the scale reduces the deviation of results and the risks associated with the deviation of personal decision making. Before the description of the Likert scale results, an explanation of the descriptive statistics was analysed to confirm that the deviation of all items was minimal.

The results were divided into five items: (i) the knowledge of LCC, (ii) the readiness towards LCC implementation, (iii) the reason to apply LCC, (iv) the proposal of LCC elements from the community sampled, and (v) the community's satisfaction level on the implementation of the LCC by the local authority.

LCCFC Implementation

This section examined the level of the community's satisfaction with the implemented effects of LCCFC and whether its implementation achieved the sustainable developmental criteria.

Based on Table 8, the low values of bias and standard deviation indicated a small deviation of responses from the respondents. The results demonstrated that the local authority should offer more opportunities for the community to address their concern in order to ascertain a higher level of community satisfaction. The statistics included the economy (0.941), environment (1.174), knowledge (5.435), social (0.118), and proposal (0.118). The level of knowledge had the most significant value in regard to the familiarity of discourse about the topic, thereby supporting the successful implementation of LCC based on community satisfaction.

The response patterns for all the constructed items exhibited a standard deviation (SD) pattern because the respondents' feedback was with varying degrees of agreement. The highest SD was social (0.065), showing the data dispersion pattern.

Table 8: Descriptive Statistics on Community Satisfaction

Item	Sample	Mean		Std. Dev Statistic (SD)
		Statistic	Bias	
Economy -> Community satisfaction	0.056	0.941	0.001	0.058
Environment_ -> Community satisfaction	0.054	1.174	0.001	0.046
Level of Knowledge -> Community satisfaction	0.278	5.435	0.001	0.049
Proposal -> Community satisfaction	0.006	0.118	0.004	0.049
Social -> Community satisfaction	0.204	3.191	0.003	0.065

Identifying the Performance Priority Criteria of LCCFC

Based on the survey, the main priority of the respondents was the comprehensive pedestrian network, with a mean of 2.39 and a median of 1.00. This represented the community reception of the item.

In contrast, the item with the lowest priority was the number of charging stations with a mean of 9.28 and a median of 10.00 (see Table 8). The respondents stated that only some of them could afford electric vehicles; therefore, respondents perceived its charging station as not a significant element in the framework.

Table 9: Performance Criteria of LCCFC Elements

Item		Mode	Mean	Median
1)	Comprehensive Pedestrian Network	1	2.39	1.00
2)	Household Solid Waste	2	4.48	4.00
3)	Open Space	3	4.00	4.00
4)	Number Of Trees	4	4.06	4.00
5)	Public Transport	5	5.15	5.00
6)	Comprehensive Cycling Network	6	4.84	5.00
7)	Walking and Cycling Facilities	7	5.48	6.00
8)	TOD concept	8	7.36	8.00
9)	Fuel-Efficient Vehicles	9	7.75	9.00
10)	Number Of Charging Stations	10	9.28	10.0
Total Criteria		10		

A total of twelve (12) LA Officers served as the respondents in the current study to share their expertise in implementing the LCCFC during the permission stage. Most of the respondents (73 %) were experts in planning permission, while 18 per cent of them were not directly in charge of planning permission, and 9 per cent had a different expertise, as they were from the Town Planning Department.

Table 10: Respondent LA Officers

Local Authority					
No.	Respondent	Gender	Position	Experience (Years)	Qualification
1.	A	Male	Deputy Director Grade J48	18	Bachelor Degree
2.	B	Female	Director Grade J48	16	Master
3.	C	Female	Assistant Director Grade J41	10	Bachelor Degree
4.	D	Female	Assistant Director (Senior) Grade J44	20	Bachelor Degree
5.	E	Female	Assistant Director (Senior) Grade J44	18	Master
6.	F	Female	Assistant Director Grade J41	6	Bachelor Degree
7.	G	Male	Assistant Director Grade J41	8	Bachelor Degree
8.	H	Male	Assistant Director Grade J41	5	Bachelor Degree
9.	I	Male	Assistant Director Grade J41	5	Bachelor Degree
10.	J	Male	Assistant Director (Senior) Grade J44	18	Bachelor Degree
11.	K	Female	Assistant Director Grade J41	8	Bachelor Degree

The readiness of implementation of LCCFC in the Planning Permission was investigated from the perspective of the LA officers to achieve the objective of unity satisfaction in economic, social, and environmental aspects. The present study revealed that LA officers could check the planning permission with LCCFC based on several factors. First, their competency to carry out their roles and responsibilities throughout the planning development process. The majority of survey respondents (80 %) indicated that they knew how to check planning permission with the LCCFC. However, the majority of respondents indicated that it is a lack of skills. They cited issues encountered during the development control planning permission process, including lack of knowledge (18 %), competency (9 %), lack of experience (9 %), lack of training (9 %) and lack of skill (28 %). In addition, the respondent stated that they lacked the ability to assess the planning permission based on the LCC in the development plan. As developers or town planning consultants submitted a detailed plan incorporating the LCCFC and referred to GreenTech for clarification, LC officers were not tasked to review development plans. Due to a lack of comprehension of the performance criteria, the developer and consultant were unable to receive a detailed explanation from LA officers. Thus, commitment among the LA officers was crucial, as indicated by the result of the interview.

> "Too costly to apply such as lack of integration among department and agencies to produce the quantitative analysis. Lack of incentives from local authorities if LCCF being applied." (Respondent B)
> "Lack of commitments due to lack of knowledge." (Respondent F)
> "It is really crucial at commitments will determine achievement." (Respondent K)

FINDINGS

The findings demonstrated the applicability of LCCFC within the existing performance criteria. The experts needed to explain in detail and assist in checking the layout plan and planning permission with LCCFC.

During the expert review, it was revealed that there was low comprehension displayed among LA officers in the use of the checklist read alongside the layout plan. Also, LA officers found reviewing the Planning Permission Plans challenging. The community satisfaction from economic, social, and environmental aspects was determined based on the results of the Analysis of Variance (ANOVA) statistical model. It was essential to determine the significant difference between the mean criteria of independent groups. It also determined the readiness level of LCCFC implementations by developers, for example, the provision of pedestrian walkways. The study found that the respondents' perceptions, according to the planning block groups, were not substantially different. In addition, there were no cost-saving implications in terms of the economic, social, and environmental effects of the implementation and achievement of LCCFC when measuring community satisfaction. It is possible to conclude that there is no significant distinction between economic, social, and environmental factors.

Lastly, the findings suggested the strategies and framework based on the results of ATLAS.ti. Hence, the study proposes that the existing LCCFC was a suitable rating tool, with the key in the system stored as a softcopy version. The LCCFC's score was based on fulfilling the conditions reached when the planning approval was requested, and the performance criteria were sought when submitting the planning permission. Based on the analysis of the ratings, the respondents must first know how to check the planning permission using the LCCF Checklist. Meanwhile, the community perception in identifying the performance priority of LCCFC was based on the ten (10) selection of criteria. Results showed that the community's selection for top performance criteria was the comprehensive pedestrian network in the LCCFC implementation.

CONCLUSION

This paper explored the community reception in the LCCFC. The first finding determined the performance criteria of LCCFC. The pedestrian walkway was selected from the ten (10) performance criteria in the community. To determine the performance criteria, knowledge is an important dimension. Hence, awareness should be enhanced among the community in achieving community satisfaction.

The second finding was the relationship between LCCFC and planning development control procedure. This aids in understanding the applicability of performance criteria in LCCFC. The knowledge and skills to understand the LCCFC in planning permission improve the LA officers' and developers' skills. Hence, training can enhance their skills. Certified facilitators are needed to assist in reviewing the layout plan with LCCFC. The effort from the state government to streamline LA into the LCCFC in a local authority is also needed. The selection of the LCCFC performance criteria is one of the main findings. The highest priority is the best findings for the performance criteria. Hence, the LA needs to consider the developer's proposed development and highlight the critical areas. The connectivity with each area is very important. The developer needs to provide a usable covered walkway to the community.

The third finding was the level of readiness for LCCFC implementation among LA officers and the community. The level of readiness is relevant to LA officers in evaluating the impact of LCCFC implemented on community satisfaction, with the measures commensurate with the readiness level. Knowledge is also important to enhance the LA's awareness of LCCFC with the planning permission and complemented with GNG. LA lacking LCCFC knowledge should be given training with coordination from the state government.

The aspect of community readiness is based on the aspects of economy, environment, knowledge, society, and proposal. The significance value is the level of knowledge that will be emphasised in the readiness of the community. The implementation of LCCFC by the LA is the effort of the leaders. LA execute LCCFC implementation on account of the readiness of the community. Competency is also an aspect highlighted in readiness from the LA which is the problem faced during the planning permission process. Enhancing the skill levels in evaluating the planning permission is the expected commitment from the developers and town planning consultants during planning permission submission. The crucial issues in LCCFC are enhancing understanding and upgrading the LA officers' skills and commitment.

The fourth finding was the relationship between community satisfaction and the implementation of LCCFC in a local authority. The current study concludes that the community benefits from implementing LCCFC in a local authority. To achieve community satisfaction, the suggestions in development control should meet the requirements based on the performance criteria. The priority performance criteria of LCCFC are based on the community proposal. For example, the comprehensive pedestrian networks are of greater significance in the LCCFC. So, developers need to provide pedestrian walkways and LA needs to facilitate by giving the length and connectivity. The relationship between the effect of LCCFC implementation and achievement towards community satisfaction level is also discovered. The findings have no significant effect on the implementation because the result showed no cost-saving implications in measuring the community's satisfaction.

Overall, the current study recommends the need to propose an action plan for LA based on the validation and acceptance of the conceptual framework for community satisfaction and sustainable development.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the support provided by Subang Jaya City Council (MBSJ), Universiti Teknologi MARA (UiTM) and are also thankful to all the departments, organisations, and individuals who had contributed to this study.

REFERENCES

Abdullah, A., Harun, Z., & Abdul Rahman, H. (2011). Planning Process of Development Project in the Malaysian Context: A Crucial Brief Overview. *International Journal of Applied Science and Technology, 1*(2), 74–81.

Act 172, (1976), Town and Country Planning Act 1976. Retrieved from https://jpbdselangor.gov.my/en/public/planning-legislation/act-172.html.

Braungart, M. (2020). What is Cradle to Cradle. *Environment and Planning* A. 1–2.

Caprotti, F., Cowley, R., Datta, A., Broto, V. C., Gao, E., Georgeson, L., New, T. (2018). The New Urban Agenda: Key Opportunities And Challenges For Policy And Practice. *Urban Research & Practice, 10*(3), 367–378. Retrieved from https://doi.org/10.1080/17535069.2016.1275618

Chin Siong, H., & Isiaka Adeyemi, A. A. (2013). Low Carbon Cities - The Way Forward in Real Estate Development in Malaysia. *Proceedings of the 26th International Business Information Management Association Conference - Innovation Management and Sustainable Economic Competitive Advantage*: From Regional Development to Global Growth, IBIMA 2015, 8(1), 3459–3469.

Chris, B. (2017). The Melting Earth. In The Melting Earth. https://doi.org/10.1007/978-0-387-68611-0_10

Christopher Wanamaker. (2020). *The Environmental, Economic, and Social Components of Sustainability*. Retrieved from https://soapboxie.com/social -issues / The-Environmental - Economic - and – Social – Components – of -Sustainability.

Dasimah, O., K. A., Othman, S., & Mohd Yusoff, Z. (2016). Walkability Design for Urban Public Housing Park. *Environment-Behaviour Proceedings Journal, 1*(3), 311. Retrieved from https://doi.org/10.21834/e-bpj.v1i3.375.

Hunter, G. W., Sagoe, G., Vettorato, D., & Jiayu, D. (2019). Sustainability Of Low Carbon City Initiatives in China: A Comprehensive Literature Review. In *Sustainability* (Switzerland) (Vol. 11, Issue 16). https://doi.org/10.3390/su11164342

Hunter, G. W., Sagoe, G., Vettorato, D., & Jiayu, D. (2019). Sustainability Of Low Carbon City Initiatives in China: A Comprehensive Literature Review. In *Sustainability* (Switzerland) (Vol. 11, Issue 16). Retrieved from https://doi.org/10.3390/su11164342.

J. Mensah (2019). Sustainable Development: Meaning, History, Principles, Pillars, And Implications for Human Action: Literature review, Retrieved from https://doi.org/10.1080/23311886.2019.1653531

Jones, C. M., Wheeler, S. M., & Kammen, D. M. (2018). Carbon Footprint Planning: Quantifying Local and State Mitigation Opportunities For 700 California Cities. *Urban Planning, 3*(2), 35–51. https://doi.org/10.17645/up.v3i2.1218

Juhari S.K., O. D., & Kamarudin Siti Mazwin, M. S. M. (2018). The Implementation Low Carbon Cities Framework (LCCF) of Local Authority in *Development Control Towards Green Cities*. LCC, 107–114.

Juhari S.K., O. D., & Kamarudin Siti Mazwin, M. S. M. (2018). The Implementation Low Carbon Cities Framework (LCCF) of Local Authority in *Development Control Towards Green Cities*. LCC, 107–114.

KeTTHA, (2017). Low Carbon Cities Framework (Version 2). Malaysia.

Khan, A. Y. (2020). Special Report A Cradle to Grave Approach: An Effective Solution for Reduction in Environmental Pollution. *Academia*, 185–188.

Lee, N. (2019). Low Carbon Cities - Malaysia's Response to Global Climate Emergency. UNDP. https://www.my.undp.org/content/malaysia/en/home/news-centre/articles/2019/lowcarboncity.html

Ministry of Energy, Green, Technology and Water (KeTTHA). (2017). Low Carbon Cities Framework, Version 2, Federal Government Administrative Centre, Retrieved from https://doi.org/ ISBN NO. 978-967-5893-09-4, Malaysia.

Noori, H. (2017). Community Participation. *Journal of Culture, Society and Development*, Vol.30, 20 (ISSN 2422-8400 An International Peer-reviewed Journal), 34. Retrieved from https://core.ac.uk/download/pdf/234691264.pdf.

PLANMalaysia@Selangor, (2021), Planning Permission, definition of ‘development’ or ‘development’ Subsyeksyen 2(1) Act 172. Retrieved from https://jpbdselangor.gov.my.

Scopelliti, M., Molinario, E., Bonaiuto, F., Bonnes, M., Cicero, L., De Dominicis, S., Fornara, F., Admiraal, J., Beringer, A., Dedeurwaerdere, T., de Groot, W., Hiedanpää, J., Knights, P., Knippenberg, L., Polajnar Horvat, K., Popa, F., Porras-Gomez, C., Smrekar, A., Soethe, N., … Bonaiuto, M. (2018). What Makes You a ‘Hero’ For Nature? Socio-Psychological Profiling of Leaders Committed to Nature and Biodiversity Protection Across Seven EU Countries. *Journal of Environmental Planning and Management, 61*(5–6), 970–993. Retrieved from https://doi.org/10.1080/09640568.2017.1421526.

Shepherd, E., Milner-Gulland, E. J., Knight, A. T., Ling, M. A., Darrah, S., Soesbergen, A., & Burgess, N. D. (2016). Status And Trends in Global Ecosystem. Molinario Et Al. 29 Services and Natural Capital: Assessing Progress Toward Aichi Biodiversity Target 14. *Conservation Letters*, 9, 429–437. Retrieved from doi:10.1111/conl.12320.

Siti Kartina; 2021, An Evaluation of Low Carbon Cities Framework (LCCF) Implementation in a Local Authority: The Case Study of Subang Jaya Municipal Council, PhD Thesis

UNCED. (1992). Report Of the United Nations Conference on Environment and Development. Rio de Janeiro, (l June 1992), 3–14. Retrieved from https://doi.org/A/CONF.151/26/Rev.l (Vol. l).

Worlds Health Organization, (2016). Community Participation in Local Health and Sustainable Development Approaches and Techniques. World Health Organization, 91.

Received: 24th July 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 173 – 187

PERCEPTUAL DIFFERENCES OF TREE REMOVAL IN DEVELOPMENT AREAS AMONG LANDSCAPE PROFESSIONALS

Khalilah Hassan[1], Wan Saiful Nizam Wan Mohamad[2], Ramly Hasan[3], Najah Md Alwi[4]

[1,2,3]*Faculty of Architecture and Ekistics,*
UNIVERSITI MALAYSIA KELANTAN
[4]*Faculty of Built Environment,*
UNIVERSITI MALAYA

Abstract

Urban areas employ proactive strategies to effectively manage their urban tree population, aiming to enhance the overall coverage of tree canopies. This process involves certified landscape practitioners (ALP) and individuals without formal professional credentials (LP) who collectively contribute to decision-making processes. However, there is limited information on the perception among these LPs. Thus, this study employed a questionnaire survey to obtain empirical observations from the perceptions of landscape professionals in both groups about tree removal by comparing similarities and differences and identifying the factors influencing existing tree removal decisions in development areas. The study used simple random sampling involving 265 respondents, 102 ALPs and 163 LPs. Descriptive and exploratory factor analysis (EFA) were used to analyse the data. Results showed that the tree removal was a common decision in urban development. Both groups of respondents agreed on three factors influencing tree removal in development areas: institutional constraints, resource availability, and cost/benefit, with institutional constraints being the primary determinant of the decision-making process. Additionally, ALPs posited that the physical environment influences tree removal decision-making. On the other hand, The LPs contended that this decision was also motivated by preferences and tree characteristics. This research advances urban tree retention literature and provides pertinent information for tree retention and management planning and strategy. Future studies may consider investigating the perceptions of different landscape professional credentials related to site design and construction to strengthen the research findings.

Keywords: tree retention, tree removal, development area, advanced landscape professionals

[1] Phd Candidate. Email: khalilah.h@umk.edu.my

INTRODUCTION

Urban trees are one of the most important tools available in cities for addressing present and future environmental challenges and, ultimately, promoting well-being. Despite the significant impact that the trees have on a community quality of life (Hall & Dickson, 2011), many cities struggle to balance between ambitious tree canopy cover objectives and urban development pressures (Ordóñez et al., 2019). The ongoing urbanisation process has resulted in the removal of an increasing number of trees to accommodate new construction projects (Brunner & Cozens, 2013). Urban trees are routinely removed to make way for new buildings, roads, parking lots, and other structures, expand their footprint, or upgrade critical infrastructure systems such as utilities (Croeser et al., 2020; Haaland & van den Bosch, 2015). As a result, a significant number of trees are removed on properties undergoing redevelopment compared to undeveloped ones (Guo et al., 2018). As tree removal is costly (Roman et al., 2022), factor influencing tree removal decisions include the tree-related characteristics, particularly the size of trees (Croeser et al., 2020; Guo et al., 2018; Morgenroth et al., 2017) and the health of trees (Conway, 2016; Guo et al., 2019). For instance, large trees require technical support and specialised equipment (Guo et al., 2018). Another reason for removal is poor tree health or risk perception, such as concerns about the dangers of falling branches or trees (Conway, 2016; Roman et al., 2022). According to Morton (2006), a tree in good health and condition and with a long-life expectancy is considered the optimal choice for retention on a development site. However, not every tree can be retained due to space limitations and other site restrictions (Ames & Dewald, 2003). The most important spatial variable for removal is the tree's proximity to a building or driveway. According to Guo et al. (2018), the tree removal is influenced by conflicts related to demolition or construction. Emerging evidence also indicates that inadequate site selection during planting processes is the primary factor contributing to tree removal (Klobucar et al., 2021). A significant correlation exists between the quality of planting space and trees (Conway, 2016) and the associated safety risks, which are the primary justifications for tree removal.

The influence of cultural dynamics, specifically individual preferences, on the removal of healthy trees was examined by Kirkpatrick, Davison and Daniels (2013) and Kirkpatrick et al. (2012). The studies found that the society's lack of active support and failure to prioritise greening cities to perceiving other needs, particularly in developing grey infrastructure, as more pressing. Additionally, some individuals view trees as problematic due shade, allergies, and the needing to clean up leaves (Kronenberg, 2014). The presence of negative perceptions towards trees has also been recognised as a contributing factor in the removal of trees (Clark et al., 2020). This is often linked to insufficient risk assessment practises, which lead to the unnecessary removal of healthy trees. The availability of tree information, including the condition and number of trees

(Kronenberg, 2014) and specialised equipment such as sonic tomographs are important in influencing tree removal decisions in development areas (Ibrahim et al., 2019). Also, as some developers prioritise profit over environmental preservation (Hasan et al., 2016), they will act to minimise the cost of development by removing trees (Nor Hanisah & Hitchmough, 2015). Based on the findings of Guo et al. (2018), economically-related factors associated with property value are significant explanatory variables in predicting tree removal at the property scale. Retaining trees by transplanting demands an overhaul in concepts and skills (Jim, 2013). Kronenberg (2014) emphasised that the preservation of urban trees faces significant challenges due to insufficient financial resources and shortcomings in managing and overseeing tree maintenance.

Moreover, institutions are identified by Kronenberg (2014) as a barrier to urban greening. Clark et al. (2020) argue that the mechanism employed for tree retention is subjective, while Kronenberg (2014) points out that current regulations do not sufficiently prioritise urban greenness. Excluding certain factors can also influence the success of tree retention implementation (Clark et al., 2020; Lavy & Hagelman, 2019). Moreover, the insufficiency of penalties, punishments, and fines imposed are highlighted by Clark et al. (2020), indicating that they may not effectively address the issue at hand. Additionally, Ibrahim et al. (2019) argue that these measures may not be suitable for the present circumstances. According to Lavy and Hagelman (2017), removing trees is connected to property ownership and the power to make alterations to real estate. Thus, the absence of a dedicated law concerning the gazetting of trees and the lack of requirement for authorities' approval for removing trees in private areas have been noted (Hasan et al., 2016).

According to O'Herrin et al. (2023) credentialing is often the incentive for continuing education by requiring practitioners to obtain new knowledge to ensure that practitioners maintain their connection to the body of knowledge and utilise it in their service to society. It is argued that perception affects decision-making, therefore, the purpose of this study was to explore the perception of landscape architects based on their professional credentials. Despite the involvement of certified landscape practitioners (ALPs) and those without formal professional credentials (LPs) in the management of urban trees, research on how they perceive tree-removal decisions, particularly in development areas, is still lacking. Therefore, this study aimed to elucidate the perspectives of advanced landscape professionals and landscape professionals regarding tree removal practises and various factors that impact their decision-making in development areas. Additionally, the study sought to determine any discernible differences in their perceptions. The scope of the present study included urban trees that were subject to management by tree professionals on private and public lands, particularly relating to development activities in Malaysia.

METHODOLOGY

Study Sample

In mid-2022, we surveyed landscape practitioners registered with the Landscape Architect Institute of Malaysia (ILAM) as corporate and graduate members for the 2021–2022 session to assess their perceptions of tree retention and removal decision-making in development areas. From the population of 829 landscape professionals, the number of samples required, based on the Krejcie & Morgan (1970) formula, is 262. Accordingly, the researcher has used a total of 265 respondents as a study sample based on the formula for determining the sample size. The study used simple random sampling. The list of landscape architects in the ILAM directory was arranged according to the sequence of membership numbers. The respondents to the survey were selected alternately on the sequence of the list. The survey started with the landscape architect at number one on the list and was followed by the next number. The selection was moved to the next person if the researcher failed to reach the intended landscape architect. This process continued until the number of respondents reached a total of 265 people. The researcher then continued the survey and managed to get 102 ALPs and 163 LPs. Their detailed demographic characteristics are presented in Table 1. In this study, ALPs are defined as respondents were certified by the Institute of Landscape Architect Malaysia (ILAM) as Landscape Architect (LAr), the International Society of Arboriculture (ISA) as Certified Arborist (CA), or the Malaysia Board of Technologists (MBOT) as Professional Technologies (Ts). Meanwhile, LPs are defined as respondents who were registered with ILAM as graduate members. Descriptively, a higher proportion of the respondents were males, mainly aged between 31 and 40 years, with bachelors' degree educational qualification and working in the private sector.

Questionnaire Design

The questionnaires used in the study for respondents were based on a literature review. It consisted of three sections. The first section comprised questions about the respondents' sociodemographic characteristics. The second section elicited information about the tree removal decision practice using dichotomous responses such as 'yes' or 'no'. The responses were coded either as 1 or 0. A score of 1 indicated respondents' agreement that trees in development areas were usually removed (response 'yes'), and 0 indicating respondents' disagreement that trees in development areas were usually removed (response 'no'). The last section, which invited respondents to provide their opinion on the tree removal rationale in the development area, was presented with Likert-scale questions of 57 statements. The respondents expressed their opinion on each of the statements, with answers given on a 5-point Likert scale anchored by 'I fully disagree' and 'I fully agree'.

Table 1: Demographic profile of the respondents: ALP (N = 102), LP (N =163)

Variable	ALP (%)	LP (%)
Gender		
Male	73	69
Female	28	31
Age		
Under 30 years	8	26
31 to 40 years	42	63
41 to 50 years	36	10
51 to 60 years	14	1
Education		
Bachelor's Degree	50	79
Master's Degree	27	13
Doctoral Degree	24	9
Employment sector		
Public sector	2	15
Statutory body	17	7
Private sector	81	77
Work Experience		
1 to 5 years	14	41
6 to 10 years	24	36
11 to 15 years	20	14
16 to 20 years	20	7
Above 21 years	24	2

Data Analysis

Reliability test

This study used Cronbachs' alpha to check the internal consistency and reliability of the questionnaire. This reliability test was performed separately between ALPs and LPs. Cronbachs' alpha test revealed that the overall score for both ALPs and LPs data were 0.972 and 0.962, respectively, indicating the items in the instrument were highly reliable.

Bartlett test of sphericity and Kaiser-Meyer-Olkin test

The Bartlett test of sphericity was conducted on the ALP (chi-square = 7080.081) and LP data (chi-square = 7807.212), with 1596 degrees of freedom and a significance level of 0.000. Both results for the Kaiser-Meyer-Olkin test for ALP (KMO = 0.637) and LP data (KMO = 0.873), exceeded 0.5. The results indicated that the EFA was appropriate for these datasets.

Exploratory Factor Analysis (EFA)

This study examined the possibility of aggregating the 57 tree removal rationale items into multiple dimensions using an EFA. The EFA was performed using the principal component method with varimax rotation according to an eigenvalue of 1.0. Items with loadings lower than 0.5 and higher than 0.4 on more than one factor were eliminated (Hair, 2010). The data were descriptively analysed, followed by testing the hypothesis to determine if there were any significant differences between groups regarding their perception of tree removal rationale. All the data analyses were performed using the Statistical Package for the Social Sciences (SPSS) software version 25.

RESULTS

Tree removal decision in development areas

Descriptive analysis

The respondents were asked, 'Are existing trees typically removed from the development area?' In this study, 'no' signified that the existing trees would be retained, as shown in Table 2. All ALP respondents reported that existing trees in development areas were typically removed, whereas 14 percent of LP respondents believed trees were usually retained in development areas.

Table 2: Respondents' perception regarding tree removal practice in development areas

Respondent	Tree removal	Frequency	%
Advanced Landscape Professional (ALP)	Yes	102	100
	No	0	0
Landscape Professional (LP)	Yes	140	86
	No	23	14

Tree removal rationale in the development areas

Exploratory factor analysis (ALP Data)

A four-factor solution with 39 variables was retained, explaining 58.1 percent of the total variance of the tree removal rationale, as presented in Table 3. Based on Table 4, the correlation between the four factors was less than 0.70 (r values between 0.330 and 0.602), indicating that the four factors were distinct constructs. Upon examining, it was determined that the items in Factor 1 were categorised in the 'Cost and Profit' construct, which related to the expenses incurred and financial gains. Similarly, the items associated with Factor 2 were found to be closely linked to 'Resource Availability', encompassing factors such as the availability of funds, staff, knowledge, expertise, and data. Furthermore, the items in Factor 3 were categorised as 'Spatial and Physical Characteristics', encompassing factors related to spatial conditions and physical elements on site. Lastly, the items within Factor 4 were classified within the construct of 'Institutional Constraints', which comprised factors relating to procedures and legislation.

Table 3: Total Variance Explained (ALP Data)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	22.58	39.62	39.62	22.58	39.62	39.62	9.25	16.23	16.23
2	4.59	8.05	47.67	4.59	8.05	47.67	9.19	16.13	32.36
3	3.10	5.44	53.11	3.10	5.44	53.11	9.09	15.94	48.30
4	2.85	4.99	58.10	2.85	4.99	58.10	5.59	9.80	58.10

Note: only eigenvalues of 1.0 or greater were listed.

Table 4: Component Transformation Matrix of ALP Data

Component	1	2	3	4
1	.556	.541	.538	.330
2	-.345	.544	-.530	.552
3	.602	-.497	-.412	.470
4	-.458	-.406	.511	.604

Exploratory factor analysis (LP Data)

A total of five factors were extracted from 30 variables retained from the LP data. They predicted as much as 56.24 percent of the overall variance of the tree removal rationale, as presented in Table 5. Table 6 show that the five factors' correlation was less than 0.80 (r values between range of 0.081 and 0.818), suggesting that the five factors were separate constructs. This study revealed that the items categorised under Factor 1 were classified as 'Resource Availability', encompassing factors such as equipment availability, staff availability, expertise availability, and data availability. The items classified under Factor 2 were associated with 'Institutional Constraint', which included factors related to procedures and legislation. The items categorised under Factor 3 were referred to as the 'Cost and Profit' construct, representing factors related to incurred expenses and financial gain. The items classified under Factor 4 were placed under the 'Preference' construct, which pertains to factors related to social characteristics. Lastly, the items categorised under Factor 5 were referred to as the 'Tree Characteristic' construct, representing factors related to the characteristics and quality of the existing trees.

Table 5: Total Variance Explained (LP Data)

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	19.35	33.95	33.95	19.35	33.95	33.95	9.52	16.70	16.70
2	3.77	6.61	40.56	3.77	6.61	40.56	6.29	11.03	27.73
3	3.22	5.64	46.20	3.22	5.64	46.20	5.96	10.45	38.18
4	2.94	5.16	51.36	2.94	5.16	51.36	5.21	9.13	47.31
5	2.79	4.89	56.24	2.79	4.89	56.24	5.09	8.93	56.24

Note: only eigenvalues of 1.0 or greater were listed.

Table 6: Component Transformation Matrix of LP Data

Component	1	2	3	4	5
1	.625	.438	.391	.378	.348
2	-.465	-.332	.751	.081	.320
3	.248	-.653	-.393	.255	.541
4	-.342	.468	-.263	-.340	.692
5	-.463	.229	-.242	.818	-.074

Mean ranking of tree removals' rationale

The results indicated that the respondents' levels of agreement with the group of factors related to the justification for tree removal fell into the categories of 'moderately agree', 'agree', and 'strongly agree', with an average value between 3.66 and 4.19, as presented in Table 7 and Table 8. The results suggested that both groups of respondents agreed that 'Institutional Constraint' (Rank 1, mean = 4.19 and 4.13, respectively) was the main reason for tree removal in development areas, followed by 'Resource Availability', (Rank 2, mean = 4.02 and 4.05, respectively). The factors 'Cost and Profit' received the lowest ranking (mean = 3.69 and 4.02, respectively). The physical environment (Rank 3, mean = 3.91) was another factor that ALPs believed affected decision-making regarding tree removal. The LPs, however, believed that the decision was also influenced by 'Preference' (Rank 3, mean = 4.01) and 'Tree Characteristic' (Rank 4, mean = 3.86).

Table 7: Result of EFA of tree removal rationale (ALP Data)

Tree removal rationale by ALP	**Factor loadings**				**Mean**
	1	**2**	**3**	**4**	
Factor 1: Cost and profit					**3.69**
High-value properties' trees aren't worth retaining.	0.77				3.54
Request by influential individuals.	0.77				3.71
Developers demanded tree removal.	0.74				3.95
Tree retention yields low profits.	0.67				3.72
Design changes to retain trees cost more.	0.67				3.79
Profit from tree-removed wood.	0.65				2.91
Trees can be replanted.	0.64				3.79
Lower removal costs than transplanting.	0.64				4.17
High tree maintenance costs	0.51				3.88
Factor 2: Resource availability					**4.02**
Insufficient funds to maintain retained trees.		0.78			4.01
Insufficient funding limits green management.		0.77			3.79
Lack of staff to manage development area trees.		0.77			3.80
Lack of economic incentives to protect urban trees.		0.73			4.09
Lack of knowledge on tree care and spp.		0.73			4.12
Tree transplantation requires an expert.		0.67			4.34
Urban tree care requires an expert.		0.66			4.14
Insufficient tree data.		0.65			3.67
Tree inventory requires an expert.		0.64			4.15
Lack of innovative tree integration.		0.60			4.09
Lack of community involvement in projects.		0.55			3.98
Factor 3: Spatial and physical characteristics					**3.91**
The area of the development site is small.			0.77		4.01
Tree growth space is limited.			0.77		4.04
Space constraints for tree transplants.			0.74		3.94
Storm-prone development area.			0.70		3.69
Retaining it threatens safety.			0.69		4.30
Retaining the tree makes it hard to adapt.			0.68		3.58
Closer construction vehicle routes.			0.66		3.63
Trees abound in the development.			0.64		3.74
Close proximity between trees and structures.			0.62		4.14
Trees with irreparable health issues.			0.54		4.35
Short tree lifespan.			0.52		3.60
Factor 4: Institutional barrier					**4.19**
Tree retention reports apply to certain projects.				0.76	4.27
Lack of comprehensive planning				0.71	4.39
Tree removal fines are disproportionate.				0.70	4.19
Planning requires fewer landscape units.				0.70	4.15
Existing laws are poorly enforced.				0.69	4.38
Tree replacement is disproportionate.				0.69	4.14
Constraints in changing existing policies.				0.51	3.80

Table 8: Result of EFA of tree removal rationale (LP Data)

Tree removal rationale by LP	**Factor loadings**					**Mean**
	1	**2**	**3**	**4**	**5**	
Factor 1: Resource availability						**4.05**
Urban tree care requires an expert.	0.81					4.15
Tree transplantation requires an expert.	0.80					4.25
Lack of tree protection equipment.	0.79					3.99
Tree inventory requires an expert.	0.77					4.22
Insufficient tree health testing equipment	0.77					4.06
Staff shortage to manage existing trees.	0.68					3.90
Insufficient tree data.	0.65					3.79
Factor 2: Institutional barrier						**4.13**
Lack of comprehensive planning		0.73				4.20
Existing laws are poorly enforced.		0.73				4.20
Tree removal fines are disproportionate.		0.66				4.28
No right to control removal on private land		0.66				4.24
No tree gazetting or retention law.		0.65				3.82
Planning requires fewer landscape units.		0.65				4.02
Factor 3: Cost and profit						**3.66**
Costly tree protection			0.85			3.75
Lower removal costs than retention costs			0.83			3.70
High tree maintenance costs			0.80			3.73
Design changes to retain trees cost more.			0.79			3.76
Lower removal costs than transplanting.			0.75			3.91
High-value properties' trees aren't worth retaining.			0.68			3.46
Tree retention yields low profits.			0.60			3.58
Profit from tree-removed wood.			0.50			3.34
Factor 4: Preferences						**4.01**
Request by influential individuals.				0.76		3.83
Developers demanded tree removal.				0.72		4.00
Lack of innovative tree integration.				0.69		4.20
Factor 5: Tree characteristic						**3.86**
Retaining the tree makes it hard to adapt.					0.70	3.82
Trees with irreparable health issues.					0.67	4.25
Retaining it threatens safety.					0.65	4.32
Short tree lifespan.					0.56	3.53
Non-native or insignificant tree.					0.54	3.74
Small canopy size or diameter.					0.52	3.53

DISCUSSION

Overall, the findings of this study suggest that the removal of existing trees is a common practice in development areas, which aligns with previous research that has identified a correlation between urban tree loss and development activities (Brunner & Cozens, 2013; Clark et al., 2020; Croeser et al., 2020; Guo et al., 2018). Removing trees is a common practice in development areas, and ALPs surveyed shared the unanimous view. Although there were slight differences between LPs, most of respondents shared similarities in their perception of implementing tree removal practices in development areas. As was expected, the ALPs and LPs had slightly different perceptions, given their different development roles. This is expected since, in practice, ALPs are responsible for preparing landscape plans and tree maintenance reports for certain projects compared to LPs (KPKT, 2019). As Kirkpatrick, Davison, & Harwood (2013) stated, tree professionals engaged in planning and strategising may have different perspectives and motivations than those who directly manage trees on the ground. For example, in a different study, certified arborists are more inclined to suggest retaining a tree instead of removing it, with four times more than to non-certified arborists (Koeser & Smiley, 2017).

The findings from this study indicate that institutional barrier is the primary factors contributing to the removal of trees in development areas. As shown in Figure 1, resource availability was identified as the subsequent determinant, while cost and profit were ranked as the least influential factors. This finding provides further evidence in line with a previous investigation that emphasised the presence of institutional deficiencies impeding urban ecosystems (Kronenberg, 2014). The institutional constraint potentially be associated with the respondent's familiarity with current legislation relating to the retention and removal of trees. As Adlin et al. (2017) concludes, although Act 172 has been in place for more than two decades, it has made little progress in terms of implementation and enforcement. Furthermore, professionals in the construction industry have a lower level of awareness of Act 172 than personnel employed by local governments (Adlin et al., 2019).

There was a significant distinction between ALPs and LPs in terms of the number of determinants proposed as factors influencing the decision to remove trees in development areas. The ALPs presented a set of four factors, while the LP posited a separate set of five factors. ALP also believed that the spatial and physical conditions of the development site were pivotal in determining whether or not trees should be removed. The ALPs believed that when determining whether to retain trees in development areas, it was important to consider the trees and the surrounding space as a single factor. On the other hand, LP considered tree characteristics as a factor in determining whether to remove them without considering the characteristics of the surrounding space. ALPs were usually involved in the evaluation of tree health, damage, and risk, which was closely tied to the planting space's quality, in preparing tree retention and removal reports could be linked to the results discussed earlier. This is due to the fact that risk assessment is a sequential process that requires careful consideration of various target, plant, and site factors, which are strongly influenced by professional experience (Koeser et al., 2015). According to Koeser and Smiley (2017) professionals with training and possessed industry credentials are found to have lower risk ratings. They are less inclined to recommend more proactive mitigation measures such as tree removal. The findings also indicate that individual preferences factor impact tree removal decisions for LPs, which aligns with previous research conducted by Kirkpatrick, Davison, and Daniels (2013) and Kirkpatrick et al. (2012). On the other hand, the ALPs considered individual preference as a determinant factor in tree removal by incorporating this aspect into the cost and profit factor. In addition, a recent study conducted by O'herrin et al. (2022), found that developers often prioritise the removal of small trees over large trees. This preference is believed to be influenced by cost and profit considerations.

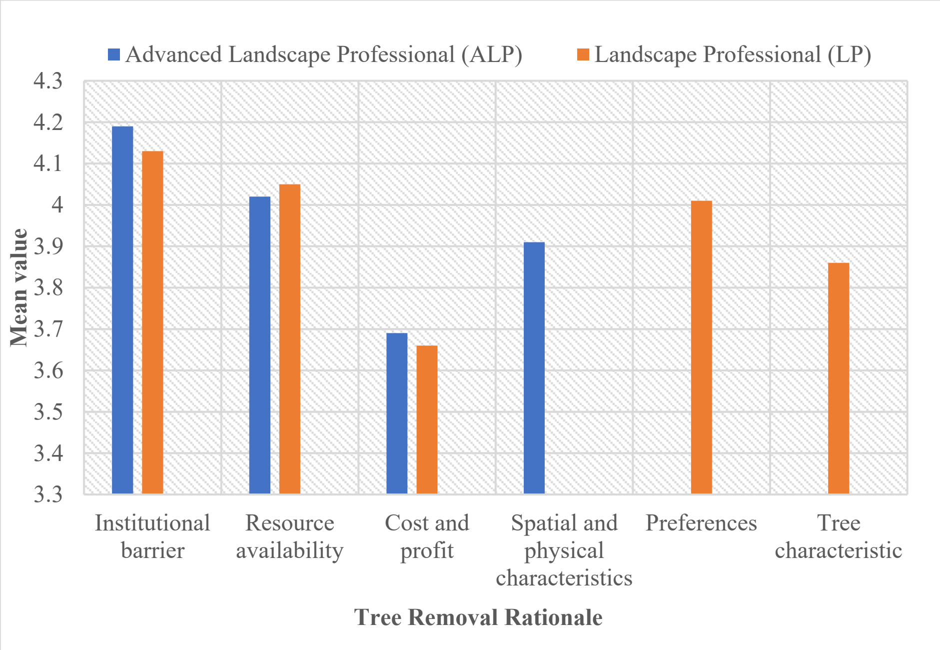


Figure 1: Group of factors pertinent to tree removal rationale

CONCLUSION

In conclusion, this study demonstrates that individuals possessing a certificate of accreditation exhibit a marginally distinct viewpoint in comparison to those lacking a professional certificate. This variety of perceptions leads to diverse actions and decisions within the profession regarding trees. Therefore, there is a possibility that diverse perceptions within the profession could lead to a variety of results, from the selection of which trees to plant, to the care of those trees, to the decision to retain or remove existing trees. This study also provides valuable insights into the factors that contribute to tree removal in development areas. Institutional barriers are found the primary factor influencing tree removal decisions, followed by resource accessibility. Thus, careful consideration of institutional factors, particularly concerning the implementation and enforcement of Act 172, is necessary for the effective management of urban trees to achieve canopy goals. This study proves the necessitates of planning involving all pertinent departments, agencies, and units that are responsible for making decisions for tree retention in development areas. Future studies may consider investigating the perceptions of different landscape professional credentials related to site design and construction to strengthen the research findings.

ACKNOWLEDGEMENTS

This research was funded by the SLAB/SLAI Unit of the Malaysian Ministry of Higher Education and Universiti Malaysia Kelantan. The authors are grateful to the research respondents for their generous time contributions.

REFERENCES

Adlin, N., Sukri, N. M., Othman, N., Tarmeze, W., & Ariffin, W. (2017). A review on the needs to improve Malaysian Tree Preservation Order (TPO) (ACT 172). *Journal of the Malaysian Institute of Planners*, *15*(4), 105–114.

Adlin, N., Sukri, N. M., Tarmeze, W., Ariffin, W., & Othman, N. (2019). Awareness and knowledge of TPO (Act 172) among construction industry professionals and local planning authority personnel in Klang Valley. *Journal of the Malaysian Institute of Planners*, *17*(2), 267–279. www.mpkj.gov.my

Ames, B., & Dewald, S. (2003). Working proactively with developers to preserve urban trees. *Cities*, *20*(2), 95–100. https://doi.org/10.1016/S0264-2751(02)00117-8

Brunner, J., & Cozens, P. (2013). "Where have all the trees gone?" Urban consolidation and the demise of urban vegetation: A case study from Western Australia. *Planning Practice and Research*, *28*(2), 231–255. https://doi.org/10.1080/02697459.2012.733525

Clark, C., Ordóñez, C., & Livesley, S. J. (2020). Private tree removal, public loss: Valuing and enforcing existing tree protection mechanisms is the key to retaining urban trees on private land. *Landscape and Urban Planning*, *203*, 1–11. https://doi.org/10.1016/j.landurbplan.2020.103899

Conway, T. M. (2016). Tending their urban forest: Residents' motivations for tree planting and removal. *Urban Forestry and Urban Greening*, *17*, 23–32. https://doi.org/10.1016/j.ufug.2016.03.008

Croeser, T., Ordóñez, C., Threlfall, C., Kendal, D., van der Ree, R., Callow, D., & Livesley, S. J. (2020). Patterns of tree removal and canopy change on public and private land in the City of Melbourne. *Sustainable Cities and Society*, *56*. https://doi.org/10.1016/j.scs.2020.102096

Guo, T., Morgenroth, J., & Conway, T. (2018). Redeveloping the urban forest: The effect of redevelopment and property-scale variables on tree removal and retention.

Urban Forestry and Urban Greening, *35*, 192–201. https://doi.org/10.1016/j.ufug.2018.08.012

Guo, T., Morgenroth, J., & Conway, T. (2019). To plant, remove, or retain: Understanding property owner decisions about trees during redevelopment. *Landscape and Urban Planning*, *190*. https://doi.org/10.1016/j.landurbplan.2019.103601

Haaland, C., & van den Bosch, C. K. (2015). Challenges and strategies for urban green-space planning in cities undergoing densification: A review. In *Urban Forestry and Urban Greening* (Vol. 14, Issue 4, pp. 760–771). Elsevier GmbH. https://doi.org/10.1016/j.ufug.2015.07.009

Hair, J. F. (2010). *Multivariate Data Analysis*. Prentice Hall.

Hall, C. R., & Dickson, M. W. (2011). Economic, environmental, and health/well-being benefits associated with green industry products and services: A review. *J. Environ. Hort*, *29*(2), 96–103. https://doi.org/https://doi.org/10.24266/0738-2898-29.2.96

Hasan, R., Othman, N., & Ahmad, R. (2016). Tree preservation order and its role in enhancing the quality of life. *Procedia - Social and Behavioral Sciences*, 493–501. https://doi.org/10.1016/j.sbspro.2016.05.140

Ibrahim, P. H., Zahrull Pauzi, H. F., & Mohd Masri, N. N. (2019). The implementation of Tree Preservation Order in urban environment: public and local authority perception. *Journal of Architecture, Planning & Construction Management*, *9*(1), 94–111.

Jim, C. Y. (2013). Sustainable urban greening strategies for compact cities in developing and developed economies. *Urban Ecosystems*, *16*(4), 741–761. https://doi.org/10.1007/s11252-012-0268-x

Kirkpatrick, J. B., Davison, A., & Daniels, G. D. (2012). Resident attitudes towards trees influence the planting and removal of different types of trees in eastern Australian cities. *Landscape and Urban Planning*, *107*(2), 147–158. https://doi.org/10.1016/j.landurbplan.2012.05.015

Kirkpatrick, J. B., Davison, A., & Daniels, G. D. (2013). Sinners, scapegoats or fashion victims? Understanding the deaths of trees in the green city. *Geoforum*, *48*, 165–176. https://doi.org/10.1016/j.geoforum.2013.04.018

Kirkpatrick, J. B., Davison, A., & Harwood, A. (2013). How tree professionals perceive trees and conflicts about trees in Australia's urban forest. *Landscape and Urban Planning*, *119*, 124–130. https://doi.org/10.1016/j.landurbplan.2013.07.009

Klobucar, B., Östberg, J., Wiström, B., & Jansson, M. (2021). Residential urban trees – socio-ecological factors affecting tree and shrub abundance in the city of Malmö, Sweden. *Urban Forestry and Urban Greening*, *62*. https://doi.org/10.1016/j.ufug.2021.127118

Koeser, A. K., Klein, R. W., Hasing, G., & Northrop, R. J. (2015). Factors driving professional and public urban tree risk perception. *Urban Forestry and Urban Greening*, *14*(4), 968–974. https://doi.org/10.1016/j.ufug.2015.09.004

Koeser, A. K., & Smiley, E. T. (2017). Impact of assessor on tree risk assessment ratings and prescribed mitigation measures. *Urban Forestry and Urban Greening*, *24*, 109–115. https://doi.org/10.1016/j.ufug.2017.03.027

KPKT. (2019). *Manual OSC 3.0 Plus Proses dan Prosedur Cadangan Pemajuan Serta Pelaksanaan Pusar Setempat (OSC)* (1st ed.).

Krejcie, R. V, & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement*, *30*, 607–610.

Kronenberg, J. (2014). Why not to green a city? Institutional barriers to preserving urban ecosystem services. *Ecosystem Services*, *12*, 218–227. https://doi.org/10.1016/j.ecoser.2014.07.002

Lavy, B. L., & Hagelman, R. R. (2019). Protecting the urban forest: Variations in standards and sustainability dimensions of municipal tree preservation ordinances. *Urban Forestry and Urban Greening*, *44*. https://doi.org/10.1016/j.ufug.2019.126394

Morgenroth, J., O'Neil-Dunne, J., & Apiolaza, L. A. (2017). Redevelopment and the urban forest: A study of tree removal and retention during demolition activities. *Applied Geography*, *82*, 1–10. https://doi.org/10.1016/j.apgeog.2017.02.011

Morton, A. (2006). Determining the retention value of trees on development sites. *7th National Street Tree Symposium*, 110–123.

Nor Hanisah, M. H., & Hitchmough, J. D. (2015). The comparisons of perceptions among landscape professionals' on tree retention and legislation article information. *International Academic Research Journal of Social Science*, *1*(2), 164–176.

O'Herrin, K., Bassett, C., Day, S., Ries, P., & Wiseman, P. E. (2023). Borrowed Credentials and Surrogate Professional Societies: A Critical Analysis of the Urban Forestry Profession. *Arboriculture & Urban Forestry*, *49*(3), 107–136. https://doi.org/10.48044/jauf.2023.009

O'herrin, K., Hauer, R., Pike, K., & Vogt, J. (2022). Homebuilder Activities and Knowledge of Tree Preservation during Construction: Comparison of Practitioners in Rural and Urban Locations. *Sustainability (Switzerland)*, *14*(5). https://doi.org/10.3390/su14052753

Ordóñez, C., Threlfall, C. G., Kendal, D., Hochuli, D. F., Davern, M., Fuller, R. A., van der Ree, R., & Livesley, S. J. (2019). Urban forest governance and decision-making: A systematic review and synthesis of the perspectives of municipal managers. *Landscape and Urban Planning*, *189*, 166–180. https://doi.org/10.1016/j.landurbplan.2019.04.020

Roman, L. A., Fristensky, J., Lundgren, R., Cerwinka, C., & Lubar, J. (2022). Construction and proactive management led to tree removals on an urban college campus. *Forests*, *13*(6). https://doi.org/10.3390/f13060871

Received: 7th June 2023. Accepted: 5th September 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 188 – 199

EXPLORING THE NEXUS OF NATURE-INTERACTION AND HUMAN NEEDS MATURITY

Aisyah Abu Bakar

[1] *Department of Environment,*
Faculty of Forestry and Environment,
UNIVERSITI PUTRA MALAYSIA

Abstract

This paper empirically explored the relationship between Interaction with Nature [IN] with three concepts, namely under Human Interdependence [HI], Subjective Well-being [SWB], and Maslow's Hierarchy of Needs [HON]. *Research Questions:* Does the fulfilment of human needs elevate IN? Is it possible for IN to increase despite unfulfilled needs, and if so, which human needs have a trivial impact on IN? *Purpose:* This paper aimed to examine the variations of IN in relation to the difficulty and convenience of fulfilling human needs. *Approach:* Mann-Whitney U Test was conducted to determine the mean variation of IN across the difficulty and convenience of fulfilling 24 human needs. *Findings:* The convenience with which 10 of the human needs could be met significantly increased IN. Meanwhile, IN did not differ significantly across the convenience and difficulty of meeting the other 12 human needs, signifying their unlikeliness to influence IN. Furthermore, an intriguing statistical result was observed where fulfilling five of the human needs and fostering IN developed along independent trajectories. Additionally, the difficulties in meeting two of the human needs, namely (i) clean water and (ii) artistic and cultural freedom, significantly elevated nature-interaction.

Keywords: interaction with nature, human interdependence with the environment, subjective well-being, Maslow's hierarchy of needs

[1] Researcher at Universiti Putra Malaysia. Email: aisyah.ab@upm.edu.my

INTRODUCTION

This paper examined the statistical interaction between meeting human needs and meaningful nature-interaction. It offers a significant contribution to the ongoing research on Human Interdependence with the Environment [HIE] by building upon previously published studies. The research also serves as an extension of the ongoing exploration in the field of positive psychology with particular emphasis on Human Interdependence [HI], Subjective Well-being [SWB], and Maslow's Hierarchy of Needs [HON].

HUMAN INTERDEPENDENCE

An increasing body of research has brought to light a novel perspective on a critical factor that influences long-term Subjective Well-being [SWB], known as Human Interdependence [HI]. SWB encompasses an individual's subjective evaluation of happiness, well-being, and life satisfaction by highlighting on the emotional, judgmental, and psychological aspects of well-being. While SWB centres on the current assessment of well-being, HI is oriented toward the future. HI focuses on the idea that changes in one's well-being are reciprocally linked to changes in the well-being of those around them due to their contributions. Consequently, the contributions one imparts to others have a positive impact on their SWB. Several authors firmly assert that HI plays a vital role in fostering sustainable well-being (Garcia et al., 2015; Kjell, 2011).

The characteristics of HI encompass both internal emotions and external circumstances. These features include belief systems, learned experiences, daily routines, involuntary actions, and intentional behaviours that instigate changes in the surrounding environments and, in turn, impact individuals' sustainable SWB. There are two recognized contexts of HI, namely Human Interdependence with Other Humans [HIH] and Human Interdependence with the Environment [HIE]. The two contexts can be expanded into four dimensions, as shown in Figure 1.

As part of a greater scientific investigation (Abu Bakar et al., 2020a; Abu Bakar et al., 2020b; Abu Bakar et al., 2018; Abu Bakar et al., 2017a; Abu Bakar et al., 2017b), this paper focuses on the second dimension of HIE, namely Interaction with Nature [IN].

INTERACTION WITH NATURE

Interaction with Nature [IN] is the second dimension of HIE that focuses on emotional empathy, closeness, familiarity, and both voluntary and involuntary interactions with the natural world. Among the numerous traits of IN are the desire to be closer to the natural environment, understanding of and empathy toward the natural environment, and health-related implications associated with one's natural surroundings (Abu Bakar et al., 2021; Abu Bakar et al., 2020c).

HI DIMENSIONS	Human Interdependence with other Humans (HIH)	Human Interdependence with the Environment (HIE)
DIMENSION 1	**Personal Empowerment (PE)**	**Eco-Personality & Lifestyle (PL)**
Lifestyles, personality, inner-strength, willpower, wisdom, awareness, and life prospects.	Focus And Resilience, Sense of Control, Self-Determination, Goal Orientation and Self-Improvement	Ecological Mindset, Collectivistic Cultures, Modesty and Moderation in Material Pursuits, and Environmental Mindfulness.
DIMENSION 2	**Positive Relationship (PR)**	**Interaction With Nature (IN)**
Intimacy, closeness, familiarity, empathy, affection, voluntary and involuntary interactions.	Affection, Compassion, Forgiveness, Ability to Tolerate Others, Sense of Inclusion and Self-Regulation.	Closeness to Nature, Knowledge of and Empathy Towards Nature, And Health Associated Attributes in Relation to Surroundings.
DIMENSION 3	**Organizational Opportunity (OO)**	**Environmental Behaviour (EB)**
Engaging with the surrounding, executing roles or tasks, proving skills and responsibility.	Articulacy and Versatility, Initiatives of Positive Interactions and Cooperative Engagements towards Professional Growth.	Careful and Conscious Decision-Making, Smart Consumerism, Recycling, Energy-Saving Initiatives, and Waste Handling.
DIMENSION 4	**Community Movement (CM)**	**External Condition (EC)**
Attitude towards circumstances, interpersonal behaviours with the larger public, etc.	Proactivity, Public Participation, Friendliness, Openness, Respect for Diversity and Sense of Belonging.	Attitudes towards Surroundings Convenience and Encouragements to be Environmentally Responsible

Figure 1: Dimensions of HIH and HIE
Source: Abu Bakar et al., 2017

IN emphasizes a sense of dependability on nature, resulting in HIE. Through these encounters, humans acquire greater awareness of their impact on the ecosystem and the interconnectedness of all living species. Such recognition develops a sense of duty for the ecosystem's and other species' well-being, supporting conservation initiatives and sustainable practices. IN also triggers the feelings of awe and amazement in the presence of natural environment. As a result, individuals will become attached to nature, ultimately discovering a profound sense of meaning and importance within the broader ecological web of life. IN also prompts individuals to develop a sense of compassion for the environment and other living beings. This altruistic perspective aligns with the transcendent value of recognizing and contributing to something beyond oneself. The construction of IN indicators based on insights from numerous literature(Abu Bakar et al., 2018; Abu Bakar et al., 2017a; Abu Bakar et al., 2017b), can be observed in Table 1.

Table 1: Definition, Factors and Indicators of Interaction with Nature (IN)

Definition	Factor	Code	Indicators
Internal and external emotions and aptitudes towards the natural environment expressed through contact with nature	Nature Attachment	IN01	outdoor environment determining own health and wellness
		IN02	being able to recall experiences in the natural environment
	Knowledge and Capability	IN03	being able to adapt to various outdoor surroundings
		IN04	being able to see and hear what others usually miss in nature
		IN05	being able to notice scientific details of nature
		IN06	being able to cope with the outdoor environment
	Inclination towards Nature	IN07	feeling the urge to spend time in the natural environment
		IN08	tending to lose concentration without contact with nature
		IN09	tending to have objects from the outdoors in personal space
		IN10	spending time planting at home

HUMAN NEEDS FULFILLMENT AND WELLBEING

Maslow's Hierarchy of Needs [HON] was originally a five-level hierarchy outlining the stages of human motivation (Maslow, 1943). The hierarchy was split into two sets: Deficiency Needs and Growth Needs. The four Deficiency Needs were Physiological Needs, Safety Needs, Love and Belonging Needs, and Esteem Needs, arranged in the order of urgency. The Growth Needs, on the other hand, was linked to self-actualization. In the 1960s and 1970s, the initial five stages of HON evolved to eight where Maslow (1962) classed Cognitive Needs and Aesthetic Needs as part of the Growth Needs. Maslow (1970) later included Transcendence Needs as the eighth and final stage of HON (see Figure 2).

Deficiency Needs are the basic needs that ensue from deprivation. When these needs are neglected, the urge to meet them intensifies with time. Persistent hunger, for example, worsens hunger. On the contrary, Growth Needs are psychological and can be fulfilled by taking part in cerebral and creative commitments. It stems from the inner desire to improve and develop as an individual. As the pinnacle of HON, Transcendence Needs can be pursued when the remaining growth needs are met. However, life challenges, such as divorce or unemployment, may cause oscillation across the different stages of HON. In reality, individuals are unlikely to progress through HON in a single direction, but they do fluctuate between the different levels.

According to Maslow (1943), individuals must first fulfil the low-level needs before progressing to the next stage of HON. For instance, meeting Esteem Needs is a prerequisite for meeting Cognitive Needs, and the same criteria apply across other HON stages. Maslow (1987) later clarified that satisfying a need is not a definitive, binary choice event. He confirmed that his earlier remarks could have created a misleading belief that a need must be entirely met before individuals can move to the next one. Needs that are lower on the HON tend to be the ones individuals have made the most progress toward, and the majority of people seem to have partially met these needs. Since human needs are adaptable and fluid, individuals can address several needs at once (Abu Bakar, 2022).

Two contrasting viewpoints are presented in the literature. First, human needs must first be met before SWB can be achieved. This means that SWB is impossible without unmet needs. Second, excessively compensating for certain needs could render individuals' ill-being. For instance, material wealth leading to unhappiness is an illustration of how addressing certain needs can be superficial. Some contend that conquering hardships, such as unfulfilled needs, enables individuals to be profoundly invested in the meanings and purposes of their lives. It is intriguing how, in certain cases, having needs that are only partially satisfied or unmet can offer life more purpose and improve SWB. Through extensive literature searches and surveys, this investigation discovered 24 indicators that outline human needs under each of the eight HON stages (see Figure 3).

		HON	UNDERSTANDING
DEFICIENCY NEEDS	1	**Physiological Needs**	The body's need for balance and consistent levels in different bodily systems is called homeostasis. It is driven by survival instincts like seeking shelter, water, food, warmth, rest, and good health. Until this need is met, all other needs are secondary.
	2	**Safety and Security Needs**	The need for safety and security in one's life and surroundings involve seeking protection from violence, health threats, sickness, and economic pressures in order to thrive in modern societies.
	3	**Belonging and Love Needs**	The need for love and a sense of belonging is fulfilled through supportive and communicative friendships, family, and intimate relationships. Deprivation of these needs can lead to feelings of guilt, loneliness, depression, or low extraversion values.
	4	**Esteem Needs**	The need for self-confidence and recognition is fulfilled through positive feelings of self-worth achieved via accomplishments, appreciation, and recognition. Without meeting this need, one may experience feelings of inferiority.
GROWTH NEEDS	5	**Cognitive Needs**	The need for knowledge and understanding is fulfilled by yearning for learning, exploration, discovery, and creation to better understand the world. Failure to fulfil this need may result in confusion and identity crisis.
	6	**Aesthetic Needs**	The need to appreciate and connect with nature's beauty which involves taking time to immerse oneself in natural surroundings, allowing the sights, sounds, and sensations of the environment to refresh and rejuvenate the mind and body.
	7	**Self-Actualization**	The instinctual need to maximize one's abilities and strive to be the best leading to a feeling of generativity –the desire to vote, contribute, volunteer, nurture and guide others to the well-being and growth of future generations or to outlast oneself.
	8	**Transcendence Needs**	The need to surpass self-centeredness, and assist others in self-fulfilment and unlocking potential, also known as spiritual needs – when fulfilled, results in a sense of integrity, elevating one's existence to a higher plane.

Figure 2: Understanding of the Stages in the Hierarchy of Human Needs
Source: Abu Bakar et al., 2022

STAGES OF HUMAN NEEDS		HON	#	HUMAN NEEDS INDICATORS
Essential Requirements *In the absence of them, the living system of mankind is obstructed.*	DEFICIENCY NEEDS	Physiological Needs	HN01	Nutritional and Wholesome Food
			HN02	Access to Medical Care
			HN03	Clean Water (for Drinking and Washing)
			HN04	Clean and Fresh Air
			HN05	Functional and Well-Maintained Lavatory
		Safety & Security Needs	HN06	Sufficient Electrical Supply
			HN07	Affordable Housing and Conveniences
			HN08	Financial Security and Stability
			HN09	Personal Safety and Security
			HN10	Health Insurance
Supplementary Requisites *In the absence of them, the living system is not obstructed but lives would be challenging*		Belonging & Love Needs	HN11	Work-Life Balance
			HN12	Social Acceptance and Cultural Inclusivity
			HN13	Reliable Communication Network
			HN14	Access to Internet with Reliable Connectivity
		Esteem Needs	HN15	Primary Education Attainment
			HN16	Secondary Education Attainment
Aspired Prospects *In the absence of them, the living system is not obstructed and lives would not be too challenging*	GROWTH NEEDS	Cognitive Needs	HN17	Tertiary Education Attainment
			HN18	Employment Prospects and Opportunities
		Aesthetic Needs	HN19	Well-Kept Areas for Recreational Activities
			HN20	Rich Biodiversity of Flora and Fauna
		Self-Actualization	HN21	Rights to Participate in Leadership Selection
			HN22	Freedom of Expression
			HN23	Opportunities Free from Corruption
			HN24	Artistic and Cultural Freedom

Figure 3: Human Needs Indicators
Source: Abu Bakar et al., 2022

TRANSCENDENCE AND INTERACTION WITH NATURE

Researchers believe that HON delivers a valuable take on the factors influencing SWB. This suggests that SWB can be enhanced by paying attention and tending to human needs, which can be prioritized and experienced differently according to individuals' personalities and circumstances. Both HON and SWB pursuits are heavily individualized; there are no set procedures for pursuing them. Some people may attain SWB through artistic activities, while others achieve SWB through relationships or by engaging in altruistic activities for the greater good.
Maslow (1970) further asserted that relatively few people in the world have experienced transcendence since it is the apex of HON and requires immense personal development and introspection. Those who achieve transcendence relish a tremendous sense of contentment and inner peace by improving the lives of others and serving the common good.

Transcendence is the desire and ability of individuals to become one with something larger or beyond their individual selves. Individuals reach selflessness and discover significant meaning and purpose in a broader cause by transcending their own identities alongside personal concerns (Koltko-rivera, 2015). Conversely, transcendence can mean pursuing a sense of oneness with the universe, nature, or a higher power, depending on one's views and ideals.

Nature has long served as a source of inspiration for artists, philosophers, and spiritual seekers. Engaging with nature elicit feelings of awe, amazement, and contemplation, ultimately offering a context for deep reflection and transcendence. In this regard, IN enriches focus as well as being entirely present in the moment. This state of mind corresponds to the essence of transcendence since both require heightened awareness of the present moment and a sensation of pushing beyond regular limitations (Abu Bakar et al., 2021; Abu Bakar et al., 2020c). Experiencing transcendence through IN cultivates a sense of tranquillity, profound introspection, and interconnectedness with the environment.

RESEARCH QUESTIONS

In light of this knowledge, the following questions were investigated in the paper: Does the fulfilment of human needs elevate IN? If yes, which human needs do this? Alternatively, is it possible for IN to increase despite unfulfilled needs, and if so, which human needs have a trivial impact on IN?

METHOD

An examination of 4,315 samples of Malaysian respondents was undertaken ensuing the data screening process. The respondents approached online and were required to respond to 10 self-reported IN items via an 11-point Likert scale. The Kolmogorov-Smirnova test revealed that the data was not normally distributed. Therefore, Mann-Whitney U Test was employed to calculate the variations of IN across the convenience and difficulty in satisfying 24 human needs.

FINDINGS

The following tabulations show the (i) mean distribution of IN items, (ii) Mann-Whitney U Test results, and (iii) Mann-Whitney U Test results' interpretation.

Table 2: Mean Distribution of IN Items

Indicators	Code	$\bar{x}$	$\bar{x}$IN
My health and wellbeing depend on the outdoor environment that I live in	IN01	8.27	7.81
I can recall old and pleasant experience when I was in the natural environment	IN02	8.19	
I can easily adapt to various types of outdoor temperature and surroundings	IN03	7.82	
I can see and hear what others usually miss in the natural environment	IN04	7.75	
I easily notice scientific details of the natural environment when I am outdoor	IN05	7.38	
I can cope the outdoor environment physically, emotionally, and intellectually	IN06	7.74	
I feel the urge to spend time with nature after a long week being indoor	IN07	7.91	
I tend to lose concentration without sufficient contact with nature	IN08	7.77	
I tend to have objects from the natural environment in my personal space	IN09	7.66	
I spend some time planting at home	IN10	7.60	

Note. Mean Distribution of IN Items ($\bar{x}$) and Overall Mean of IN ($\bar{x}$IN)

Table 3: Mann Whitney U-Test Results

HON STAGES	HUMAN NEEDS	Difficult			Convenient			U	z	p
		N	$\bar{x}R$	$\tilde{x}$	N	$\bar{x}R$	$\tilde{x}$			
Physiological Needs	HN1	336	2137.64	7.9	3979	2159.72	8.0	661632.5	-.312	.755
	HN2	423	2076.00	7.8	3892	2166.91	8.0	788473.5	-1.426	.154
	HN3	392	**2348.89**	8.2	3923	2138.93	7.9	694079.0	-3.183	.001
	HN4	1330	2002.27	7.8	2985	**2227.39**	8.0	1777905.0	-5.483	.000
	HN5	805	2098.78	7.9	3510	2171.58	8.0	1365100.5	-1.496	.135
Safety & Security Needs	HN6	428	2087.98	7.9	3887	2165.71	8.0	801849.0	-1.225	.220
	HN7	1114	2179.42	8.0	3201	2150.54	8.0	1759090.5	-.667	.505
	HN8	1861	2083.48	7.9	2454	**2214.51**	8.0	2144770.5	-3.423	.001
	HN9	1578	2010.32	7.8	2737	**2243.14**	8.0	1926460.0	-5.914	.000
	HN10	1325	2041.66	7.8	2990	**2209.55**	8.0	1826728.5	-4.085	.000
Belonging & Love Needs	HN11	1582	1991.20	7.7	2733	**2254.55**	8.1	1897920.0	-6.693	.000
	HN12	1310	2023.32	7.8	3005	**2216.71**	8.0	1791840.5	-4.690	.000
	HN13	328	2171.30	8.0	3987	2156.91	8.0	649505.0	-.201	.841
	HN14	923	2173.37	8.0	3392	2153.82	8.0	1551218.0	-.423	.672
Esteem Needs	HN15	313	2284.32	8.1	4002	2148.12	7.9	586775.0	-1.863	.062
	HN16	390	2148.64	7.9	3925	2158.93	8.0	761726.5	-.156	.876
Cognitive Needs	HN17	836	2107.19	7.9	3479	2170.21	8.0	1411744.0	-1.314	.189
	HN18	1678	2091.32	7.9	2637	**2200.43**	8.0	2100553.0	-2.805	.005
Aesthetic Needs	HN19	1430	1993.60	7.8	2885	**2239.49**	8.1	1827686.5	-6.105	.000
	HN20	1453	1929.85	7.7	2862	**2273.83**	8.1	1747747.5	-8.574	.000
Self-Actualization	HN21	1823	2041.64	7.8	2492	**2243.12**	8.1	2059330.0	-5.249	.000
	HN22	336	2137.64	7.9	3979	2159.72	8.0	661632.5	-.312	.755
	HN23	423	2076.00	7.8	3892	2166.91	8.0	788473.5	-1.426	.154
	HN24	392	**2348.89**	8.2	3923	2138.93	7.9	694079.0	-3.183	.001

Note. Mean Rank of $\bar{x}\Sigma$ IN across Difficult and Convenient; ***Bold*** *and highlighted shows higher mean rank.*

The analysis showed that 12 out of 24 test results were statistically significant, therefore suggesting that IN was statistically convenient in fulfilling all of the highlighted human needs (see Table 3).

Table 4: Mann Whitney U-Test Results Interpretation

HON	HUMAN NEEDS	INTERPRETATION
Physiological Needs	Nutritional and Wholesome Food	Respondents who indicated convenient had higher mean rank (N = 3979, $\bar{x}R$ = 2159.72) than those who reported difficult (N = 336, $\bar{x}R$ = 2137.64), but the difference did not reach statistical significance (U = 661632.5, p = .755).
	Access to Medical Care	Respondents who indicated convenient had higher mean rank (N = 3892, $\bar{x}R$ = 2166.91) than those who reported difficult (N = 423, $\bar{x}R$ = 2076.00), but the difference did not reach statistical significance (U = 788473.5, p = .154).
	Clean Water (For Drinking and Washing)	Respondents who indicated difficult had higher mean rank (N = 392, $\bar{x}R$ = 2348.89) than those who reported convenient (N = 3923, $\bar{x}R$ = 2138.93). A significant statistical difference was observed (U = 694079.0, p = .001).
	Clean and Fresh Air	Respondents who indicated convenient had higher mean rank (N = 2985, $\bar{x}R$ = 2227.39) than those who reported difficult (N = 1330, $\bar{x}R$ = 2002.27). A significant statistical difference was observed (U = 1777905.0, p = .000).
	Functional and Well-Maintained Lavatory	Respondents who indicated convenient had higher mean rank (N = 3510, $\bar{x}R$ = 2171.58) than those who reported difficult (N = 805, $\bar{x}R$ = 2098.78), but the difference did not reach statistical significance (U = 1365100.5, p = .135).
Safety and Security Needs	Sufficient Electrical Supply	Respondents who indicated convenient had higher mean rank (N = 3887, $\bar{x}R$ = 2165.71) than those who reported difficult (N = 428, $\bar{x}R$ = 2087.98), but the difference did not reach statistical significance (U = 801849.0, p = .220).
	Affordable Housing and Conveniences	Respondents who indicated difficult had higher mean rank (N = 1114, $\bar{x}R$ = 2179.42) than those who reported convenient (N = 3201, $\bar{x}R$ = 2150.54), but the difference did not reach statistical significance (U = 1759090.5, p = .505).
	Financial Security and Stability	Respondents who indicated convenient had higher mean rank (N = 2454, $\bar{x}R$ = 2214.51) than those who reported difficult (N = 1861, $\bar{x}R$ = 2083.48). A significant statistical difference was observed (U = 2144770.5, p = .001).
	Personal Safety and Security	Respondents who indicated convenient had higher mean rank (N = 2737, $\bar{x}R$ = 2243.14) than those who reported difficult (N = 1578, $\bar{x}R$ = 2010.32). A significant statistical difference was observed (U = 1926460.0, p = .000).
	Health Insurance	Respondents who indicated convenient had higher mean rank (N = 2990, $\bar{x}R$ = 2209.55) than those who reported difficult (N = 1325, $\bar{x}R$ = 2041.66). A significant statistical difference was observed (U = 1826728.5, p = .000).
Belonging and Love Needs	**Work-Life Balance**	Respondents who indicated convenient had higher mean rank (N = 2733, $\bar{x}R$ = 2254.55) than those who reported difficult (N = 1582, $\bar{x}R$ = 1991.20). A significant statistical difference was observed (U = 1897920.0, p = .000).
	Social Acceptance and Cultural Inclusivity	Respondents who indicated convenient had higher mean rank (N = 3005, $\bar{x}R$ = 2216.71) than those who reported difficult (N = 1310, $\bar{x}R$ = 2023.32). A significant statistical difference was observed (U = 1791840.5, p = .000).
	Effective Communication Network	Respondents who indicated difficult had higher mean rank (N = 328, $\bar{x}R$ = 2171.30) than those who reported convenient (N = 3987, $\bar{x}R$ = 2156.91), but the difference did not reach statistical significance (U = 649505.0, p = .841).
	Access to Internet with Reliable Connectivity	Respondents who indicated difficult had higher mean rank (N = 923, $\bar{x}R$ = 2173.37) than those who reported convenient (N = 3392, $\bar{x}R$ = 2153.82), but the difference did not reach statistical significance (U = 1551218.0, p = 672.).
Esteem Needs	Primary Education Attainment	Respondents who indicated difficult had higher mean rank (N = 313, $\bar{x}R$ = 2284.32) than those who reported convenient (N = 4002, $\bar{x}R$ = 2148.12), but the difference did not reach statistical significance (U = 586775.0, p = .062).
	Secondary Education Attainment	Respondents who indicated convenient had higher mean rank (N = 390, $\bar{x}R$ = 2158.93) than those who reported difficult (N = 3925, $\bar{x}R$ = 2148.64), but the difference did not reach statistical significance (U = 761726.5, p = .876).
Cognitive Needs	Tertiary Education Attainment	Respondents who indicated convenient had higher mean rank (N = 3479, $\bar{x}R$ = 2170.21) than those who reported difficult (N = 836, $\bar{x}R$ = 2107.19), but the difference did not reach statistical significance (U = 1411744.0, p = .189).
	Employment Prospects and Opportunities	Respondents who indicated convenient had higher mean rank (N = 2637, $\bar{x}R$ = 2200.43) than those who reported difficult (N = 1678, $\bar{x}R$ = 2091.32). A significant statistical difference was observed (U = 2100553.0, p = .005).

Note. Result Interpretation of Mann Whitney U Test; Bold & Highlighted shows statistically significant output.

Table 4: Mann Whitney U-Test Results Interpretation (continued)

HON	HUMAN NEEDS	INTERPRETATION
Aesthetic Needs	**Well-Kept Areas for Recreational Activities**	Respondents who indicated convenient had higher mean rank (N = 2885, $\bar{x}R$ = 2239.49) than those who reported difficult (N = 1430, $\bar{x}R$ = 1993.60). A significant statistical difference was observed (U = 1827686.5, p = .000).
	Rich Biodiversity of Flora and Fauna	Respondents who indicated convenient had higher mean rank (N = 2862, $\bar{x}R$ = 2273.83) than those who reported difficult (N = 1453, $\bar{x}R$ = 1929.85). A significant statistical difference was observed (U = 1747747.5, p = .000).
Self-Actualization Needs	**Rights to Participate in Leadership Selection**	Respondents who indicated convenient had higher mean rank (N = 2492, $\bar{x}R$ = 2243.12) than those who reported difficult (N = 1823, $\bar{x}R$ = 2041.64). A significant statistical difference was observed (U = 2059330.0, p = .000).
	Freedom of Expression	Respondents who indicated convenient had higher mean rank (N = 3979, $\bar{x}R$ = 2159.72) than those who reported difficult (N = 336, $\bar{x}R$ = 2137.64), but the difference did not reach statistical significance (U = 661632.5, p = .755).
	Opportunities Free from Corruption	Respondents who indicated convenient had higher mean rank (N = 3892, $\bar{x}R$ = 2166.91) than those who reported difficult (N = 423, $\bar{x}R$ = 2076.00), but the difference did not reach statistical significance (U = 788473.5, p = .154).
	Artistic and Cultural Freedom	Respondents who indicated difficult had higher mean rank (N = 392, $\bar{x}R$ = 2348.89) than those who reported convenient (N = 3923, $\bar{x}R$ = 2138.93). A significant statistical difference was observed (U = 694079.0, p = .001).

Note. Result Interpretation of Mann Whitney U Test; Bold & Highlighted shows statistically significant output.

Table 5: Summary of Findings

Statistically Significant Difference Established (p < .000)		Difference Did Not Reach Significance
Condition 1: IN Increase with Difficulty	**Condition 2:** IN Increase with Convenient	**Condition 3:** Neither Change IN
The difficulty to meet the human need increases IN, or IN is greater with difficulty to meet the human need.	The convenience to meet the human need increases IN, or IN is greater with convenience to meet the human need.	Neither convenience or difficulty to meet the human need increases IN, or IN does not change with convenience nor difficulty to meet the human need.

	HON	Code	Human Needs	Findings/Condition
DEFIENCY NEEDS	Physiological Needs	HN01	Nutritional and Wholesome Food	Condition 3
		HN02	Access to Medical Care	Condition 3
		HN03	Clean Water (for Drinking and Washing)	**Condition 1**
		HN04	Clean and Fresh Air	**Condition 2**
		HN05	Functional and Well-Maintained Lavatory	Condition 3
	Safety & Security Needs	HN06	Sufficient Electrical Supply	Condition 3
		HN07	Affordable Housing and Conveniences	Condition 3
		HN08	Financial Security and Stability	**Condition 2**
		HN09	Personal Safety and Security	**Condition 2**
		HN10	Health Insurance	**Condition 2**
	Belonging & Love Needs	HN11	Work-Life Balance	**Condition 2**
		HN12	Social Acceptance and Cultural Inclusivity	**Condition 2**
		HN13	Reliable Communication Network	Condition 3
		HN14	Access to Internet with Reliable Connectivity	Condition 3
	Esteem Needs	HN15	Primary Education Attainment	Condition 3
		HN16	Secondary Education Attainment	Condition 3
GROWTH NEEDS	Cognitive Needs	HN17	Tertiary Education Attainment	Condition 3
		HN18	Employment Prospects and Opportunities	**Condition 2**
	Aesthetic Needs	HN19	Well-Kept Areas for Recreational Activities	**Condition 2**
		HN20	Rich Biodiversity of Flora and Fauna	**Condition 2**
	Self-Actualization	HN21	Rights to Participate in Leadership Selection	**Condition 2**
		HN22	Freedom of Expression	Condition 3
		HN23	Opportunities Free from Corruption	Condition 3
		HN24	Artistic and Cultural Freedom	**Condition 1**

The mean distribution across IN items, varying from 7.38 to 8.27, indicated that the Malaysian respondents had a strong positive sentiment on IN (see Table 2). All of them were asked to indicate whether the human needs were convenient or difficult to meet. Most respondents—between half and three-quarters—claimed it was convenient to meet all of the 24 needs (see Table 3). The Mann-Whitney U Test was then performed using the averaged means of all IN items. The mean variations of IN were compared between two positions (convenient and difficult).

The statistical findings indicated that IN increased when 10 of the human needs were convenient to meet. These needs were (i) clean and fresh air, (ii) financial security and stability, (iii) personal safety and security, (iv) health insurance, (v) work-life balance, (vi) social acceptance and cultural inclusivity, (vii) employment prospects and opportunities, (viii) well-kept areas for recreational activities, (ix) rich biodiversity of flora and fauna, and (x) rights to participate in leadership selection. Interestingly, the difficulty of meeting 2 of the human needs, namely (i) clean water and (ii) artistic and cultural freedom, significantly elevated IN. Nevertheless, IN did not significantly change with convenience nor difficulty to fulfil the remaining 12 human needs (see Table 4 and Table 5.

DISCUSSION AND CONCLUSION

Interestingly, the findings showed that difficulties in meeting clean water and artistic and cultural freedom as well as convenience in meeting the 10 of highlighted human needs fosters nature-interaction. Additionally, meeting human needs and fostering IN can grow along separate paths, as evidenced by the lack of statistical interactions between IN and the remaining 12 human needs.

Difficulties in access to clean water may drive individuals to become ecologically conscious and advocate for water conservation. When individuals are inaccessible to clean water infrastructure, they may turn to nature as the natural source for crucial backup options. A greater connection to nature and its cycles may be fostered through difficulties in getting clean water. As individuals grow more conscious of the need to protect and maintain water supplies, they may interact with nature more to better understand its dynamics and manage water resources.

The concept of compensatory behaviour in psychology may help to explain why there was a significant rise in IN when artistic and cultural freedom were difficult to attain. Individuals may seek solace and fulfilment elsewhere when faced with restrictions in one area of their lives. An opportunity to detach from daily struggles and experience serenity and tranquillity can be found by spending time in nature. This suggests that immersion in nature provides means for unconstrained self-expression. Additionally, a sense of independence and release from restraints can be attained via IN.

REFERENCES

Abu Bakar, A., Mohamed Osman, Mariana Bachok, S., Ibrahim, M., Abdullah, A. (2017a). Sustainable Well-Being: An Empirical Exploration on Human Interdependence with the Environment. *Advanced Science Letters*, *23*(7), 6357-6361(5). https://doi.org/https://doi.org/10.1166/asl.2017.9269

Abu Bakar, A., Mohamed Osman, M., Bachok, S., & Ibrahim, M. (2017b). Sustainable Well-Being Subjective Indicators: Human Interdependence with Other Humans and with the Environment. In B. McLellan (Ed.), *Sustainable Future for Human Security* (pp. 301–318). Springer, Singapore.

Abu Bakar, A., Mohamed Osman, M., Bachok, S., Hitam, M., & Abdullah, A. (2018). Human Interdependency for Sustainable Well-Being: Structural Invariance across Settlement Areas. *PLANNING MALAYSIA Journal of the Malaysia Institute of Planners*, *16*(1), 281–293.

Abu Bakar, A., Osman, M. M., & Hitam, M. (2020a). Personality and Lifestyle Interprets External Condition to Environmental Behaviours. *PLANNING MALAYSIA Journal of the Malaysia Institute of Planners*, *18*(1), 56–65.

Abu Bakar, A., Osman, M. M., Hitam, M. (2020b). Attitudes and Pro-Environmental Behaviours: Determining Factor of Personality and Lifestyle. *PLANNING MALAYSIA Journal of the Malaysia Institute of Planners*, *18*(1), 1–10. https://doi.org/10.21837/pm.v18i11.704

Abu Bakar, A. Osman, M. M., & Hitam, M. (2020c). The Impact of Personality and Lifestyle on Interaction with Natire. *PLANNING MALAYSIA Journal of the Malaysia Institute of Planners*, *18*(1), 35–44.

Abu Bakar, A., Mustapa, S. I., & Mohammad, N. (2021). Green City Initiatives: Human-Nature Interaction. *PLANNING MALAYSIA Journal of the Malaysia Institute of Planners*, *19*(1), 13–24.

Abu Bakar, A. (2022). Hierarchy of Needs and Subjective Wellbeing. *Planning Malaysia*, *20*(4), 377–390. https://doi.org/10.21837/pm.v20i24.1213

Garcia, D., Anckarsäter, H., Kjell, O. N. E., Archer, T., Rosenberg, P., Cloninger, C. R., & Sikström, S. (2015). Agentic, communal, and spiritual traits are related to the semantic representation of written narratives of positive and negative life events. *Psychology of Well-Being*, *5*(1), 8. https://doi.org/10.1186/s13612-015-0035-x

Kjell, O. N. E. (2011). Sustainable well-being: A potential synergy between sustainability and well-being research. *Review of General Psychology*, *15*(3), 255–266. https://doi.org/10.1037/a0024603

Koltko-rivera, M. E. (2015). *Rediscovering the later version of Maslow ' s hierarchy of needs : Self- transcendence and opportunities for theory , research , and unification Rediscovering the Later Version of Maslow ' s Hierarchy of Needs : and Unification*. *August*. https://doi.org/10.1037/1089-2680.10.4.302

Maslow, A. H. (1943). *A theory of human motivation*. Physchological Review. http://psychclassics.yorku.ca/Maslow/motivation.htm

Maslow, A. H. (1962). *Toward a Psychology of Being*. D. Van Nostrand Company.

Maslow, A. H. (1970). *Motivation and Personality* (Second Edition). Harper & Row.

Maslow, A. H. (1987). *Motivation and Personality* (Third Edition). New York: Harper & Row.

Received: 26th June 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 200 – 210

COMPETITIVENESS INDEX OF PENINSULAR MALAYSIA'S NORTHERN BORDER DISTRICTS

Jamalunlaili Abdullah[1], Muhammad Hakim Danial[2], Mazrina Abdul Khalid[3], Abdullah Ab Rahman[4], Azren A Karim[5]

[1,2] *College of Built Environment,*
UNIVERSITI TEKNOLOGI MARA
[3,5] URBAN SCALE
[4] PLANMALAYSIA@ KEDAH

Abstract

Competitive cities are known for their substantial economic growth, high incomes, and the ability to attract foreign investments. While a strong economy is crucial, other factors such as effective governance, efficient transportation, adequate housing, social inclusivity, and environmental sustainability also contribute to a city's competitiveness. This paper aims to assess the economic competitiveness of border districts in northern Peninsular Malaysia. Border cities hold significant importance following their proximity to neighbouring countries, subsequently offering advantages in terms of trade opportunities, cultural exchange, diplomatic relations, security, and socio-cultural integration. This research employed the quantitative method to measure the competitiveness level of 10 districts using economic and socioeconomic statistical data from the Department of Statistics Malaysia. The results indicated a distinct disparity among the districts along the Malaysia-Thailand border. In particular, the western districts of Perlis and Kubang Pasu displayed a higher level of economic development compared to the rural eastern districts due to their economic diversity and close proximity to industrial hubs such as Penang, Sungai Petani, and Songkhla in Southern Thailand. Furthermore, the strategic locations of the busiest international entry points, Bukit Kayu Hitam and Padang Besar, contribute significantly to the importance of logistics in these areas. In contrast, the middle and eastern districts heavily rely on agricultural activities, resulting in lower average incomes and higher poverty rates.

Keywords: Competitive cities, Competitiveness index, Economic growth, Border towns, Malaysia-Thailand

[1] Professor at Universiti Teknologi MARA. Email: jamal858@uitm.edu.my

INTRODUCTION

Cities around the world continue to urbanise and eventually compete with each other. Competitive cities typically experience significant economic growth, high incomes, and attract foreign investments. While economies play a crucial role in city competitiveness, the phenomenon is also believed to be contributed by various other factors, such as good governance, efficient transportation and traffic management, sufficient housing, social inclusivity, and environmental sustainability.

There is a growing body of literature that studies city competitiveness (see Sáez & Periáñez, 2015; Sáez, Periáñez, & Saizarbitoria, 2017; Sgambati & Gargiulo, 2022; Tennøy, Gundersen, & Øksenholt, 2022). However, many of these studies use different approaches to define and measure urban competitiveness due to the multitude of variables and factors involved. Sáez et al. (2015) introduced three dimensions to examine city competitiveness: basic dimension, efficiency dimension, and innovation dimension. Harris (2007), on the other hand, used different dimensions related to transportation, security, and housing. Moreover, the Economic Planning Unit (2015) created a multidimensional framework to define city competitiveness, which includes economic growth, good urban governance, social inclusion, and environmental sustainability. Due to the complexity of factors driving city competitiveness, researchers have been unable to establish a universal definition or standardised measurement methods. Therefore, studying these various dimensions and factors can provide a better understanding of city competitiveness and identify strategies to enhance it.

The aim of this research was to evaluate the competitiveness of northern international border cities in Peninsular Malaysia. Border towns are significant due to their proximity to neighbouring countries and unique geographic location. They offer advantages such as trade opportunities, cultural exchange, diplomatic relations, security, and socio-cultural integration. Additionally, these towns serve as trade hubs, promote cross-cultural understanding, facilitate diplomacy, ensure border control, and encourage collaboration in various fields. Harnessing the potential of border towns can bring substantial benefits to both local communities and the broader region. Assessing various dimensions and factors of such notion will offer insights into the competitiveness of these districts. Findings from this research shall provide valuable information for policymakers and city planners in enabling them to identify strengths and weaknesses, develop strategies for improvement, and enhance the overall competitiveness of the districts.

LITERATURE REVIEW

Definition of urban competitiveness

Researchers have used various methodologies and criteria to evaluate cities' competitiveness. However, there is currently no widely accepted universal set of definitions, methodologies, frameworks, and criteria for assessing competitiveness (Economic Planning Unit, 2015). Studies on urban competitiveness recognise that it is complex in nature, involving multiple dimensions and characteristics that influence cities' ability to attract investments, generate employment, and attract a skilled workforce (Sgambati & Gargiulo, 2022).

According to Sáez and Periáñez (2015), urban competitiveness refers to the ability of cities to meet the demands of national and global markets while improving the socioeconomic quality of life for their residents through sustainable development. Cities with strong and stable economies have a certain level of autonomy from their national economies and can compete on a global scale. The performance of a country's economy is influenced by the competitiveness of its cities, which are less dependent on domestic markets. It involves creating favourable conditions for economic activities to thrive, subsequently attracting investment as well as generating wealth and employment (Sáez, Periáñez, & Saizarbitoria, 2017).

Competition and competitiveness are two interconnected yet distinct concepts. Competitiveness is the result of competition, and cities need to be competitive to thrive (Sáez & Periáñez, 2015). A competitive city creates an environment that is conducive to competitiveness with effective public institutions, innovative businesses, and supportive infrastructure. Achieving true competitiveness requires the presence of resources, capabilities, and institutions that leverage the city's competitive advantage. However, not all cities compete under the same conditions and they vary in terms of resources, strength, and capabilities to contend with competitors.

A recent study conducted by the UNHABITAT & CASS (2020) indicated that the global economic competitiveness of cities in 2019 and 2020 was influenced by a decline in the average urban competitiveness across major countries such as China, the United States, and Europe. This subsequently prompted a slight decrease in global urban competitiveness. Essentially, the ongoing trade war among these countries not only undermines the urban competitiveness of each nation but also carries negative implications for global urban competitiveness and overall welfare.

Characteristics of competitive cities

According to the 2005 to 2012 data from the World Bank Group (2015), the difference between comparative and average cities mainly lies on four main characteristics. The first characteristic is accelerated economic growth where the top 10 percent of cities experienced an impressive annual Gross Domestic Product (GDP) per capita growth of 13.5 percent, while the average cities only saw a growth of 4.7 percent. The second characteristic is significant job growth where the top 10 percent of cities achieved an annual job growth rate of 9.2 percent, which was significantly higher than the 1.9 percent obtained by the remaining 90 percent of cities. The third characteristic is increased income and productivity where the top 10 percent of cities recorded a notable yearly increase of 9.8 percent in the average disposable income of their households. The final characteristic is attraction for Foreign Direct Investment (FDI) where the top 5 percent of cities attracted an amount of FDI that was equal to the combined FDI of the bottom 95 percent of cities.

Furthermore, the study by Sáez, Periáñez, and Saizarbitoria (2017) also confirmed the importance of economic activity and innovation dimension as the key drivers of urban competitiveness and development in Europe. The service sector emerged as highly significant across all factors related to economic activity. This sector relies on a skilled workforce and higher education, making it a crucial determinant of urban competitiveness. Similarly, factors such as knowledge generation, information and communication technologies (ICT), and the sophistication of high-value organisations play a critical role within the innovation dimension.

Apart from economic factors, Harris (2007) examined the competitiveness of cities in four Latin American countries by focusing on three sectors: transportation, security, and housing. The transportation sector emerged as the most critical following its involvement in global supply chains. While the physical infrastructure of transportation (e.g., highways, airports, and seaports) often receives the most attention, effective management of traffic flow within the city holds even greater economic significance. This indicates that insufficient traffic management can directly impede the cities' economic competitiveness. Moreover, these cities play a vital role in meeting the demands of external consumers through markets, retail trades, and the provision of producer services.

Similarly, a study by Gundersen, Langeland, and Aarhaug (2016) explored the factors that made certain parts of the city in the Oslo region, Norway to be more appealing to businesses and individuals. They examined the attractiveness of cities by considering factors such as location, proximity, and accessibility. Both accessibility and the efficiency of the transport system were found to be significant in enhancing the city's appeal and fostering industrial development, although certain variations existed across industries. However, it is important to note that an efficient transport system alone is insufficient to make specific areas of a city attractive to particular industries. Several other location-based factors, including labour availability, land availability, access to capital, and the presence of managerial and technical skills, can also influence the overall attractiveness and competitiveness of a city.

In addition to these empirical studies, several dimensions have also been identified as contributing factors to urban competitiveness. This includes social and cultural capital, housing, quality of life and place, public institutions, infrastructure, accessibility, environment, economy and employment, city branding, as well as research and innovation (Sgambati & Gargiulo, 2022).

In the Malaysian context, the Economic Planning Unit (2015) adopted a multi-dimensional framework to define competitive cities in order to provide recommendations that can assist Malaysia in advancing towards a system of competitive cities. The key elements encompassed within this framework include economic growth, effective urban governance, social inclusion, and environmental sustainability. First, cities drive economic growth through the availability of skilled workers, connectivity, and a thriving knowledge-based economy. Nevertheless, challenges like inadequate infrastructure may hinder growth. Second, effective urban governance is important to provide services, fair markets, and a sustainable environment. Third, inclusive cities often promote social or public participation and well-being, subsequently addressing inequalities and reducing crime. Finally, environmental sustainability is vital for cities to balance economic and social needs; however, it requires a careful assessment of infrastructure trade-offs. Additionally, green and resilient investments are crucial for cities to achieve economic returns, enhance quality of life, and attract talent, ultimately contributing to its competitiveness.

RESEARCH METHODOLOGY

This research employed the quantitative method to measure the competitiveness level of 10 districts at the northern border of Malaysia: Perlis, Kubang Pasu, Padang Terap, Sik, Baling, Hulu Perak, Jeli, Tanah Merah, Pasir Mas, and Tumpat (Figure 1). Quantitative methods were chosen to evaluate the economic and socio-economic performance based on statistical data produced by the Malaysian government. All data were gathered through secondary sources obtained from the Department of Statistics Malaysia (DOSM). Economic and socio-economic factors were chosen as variables in this research following their significant contribution to the competitiveness level of cities, as reported by past literature (See Literature Review section). These factors include the number of non-citizen populations, the values of imports and exports in the trading sector, the investment value in manufacturing projects, the labour force, the working population, the labour force participation rate, the unemployment rate, the number of domestic university graduates, the average income, and the absolute poverty rate.

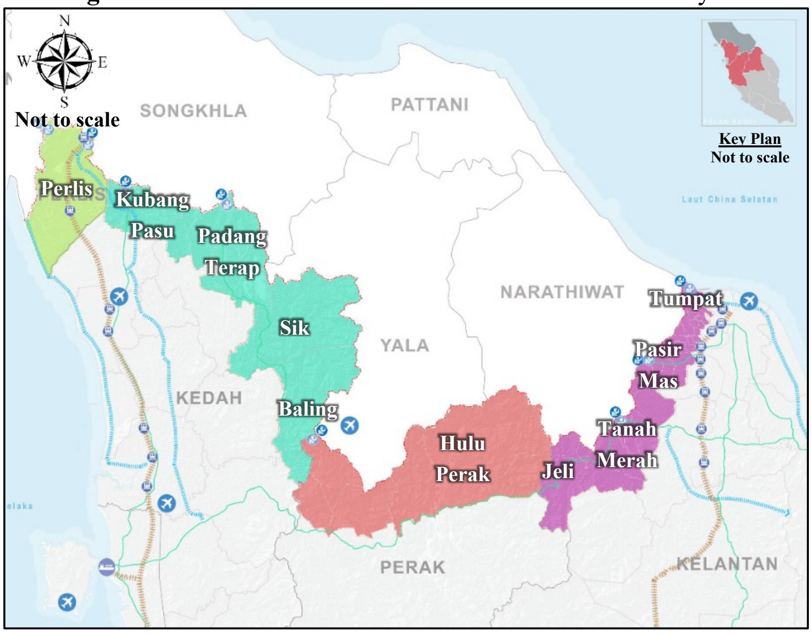
To quantify the variables, mean and standard deviation were used to determine the score, categorised as 0 (no contribution if no value/data), 1 (low contribution), 2 (average/high contribution), or 3 (high contribution).

Mean values were used as an indicator for low and high contributions if a variable only contained a few data – e.g., only a few districts obtained investment in manufacturing projects, therefore, only the score of 1 (low) or 2 (high) was given. Meanwhile, score 0 was assigned in the presence of no data. For example, if the values of a variable are above the mean, the score given is 2. On the contrary, if the values are below the mean, the score will be 1.

On the other hand, standard deviation was used as an indicator for low, average, and high if a variable contained data for all districts – e.g., labour force and working population. For example, if the values of a variable fall within the first standard deviation, the score will be 2. In contrast, if the values fall within the second standard deviation, the score will be either 1 (low-end) or 3 (high-end).

The scores for each variable were then accumulated to obtain the total score. The total score served as an indicator to measure the economic and socio-economic competitiveness among the selected districts, where a higher score indicated higher economic performance.

Figure 1: Districts at the northern border of Penisular Malaysia



ANALYSIS AND DISCUSSION

Table 1 shows the eleven variables used to measure the competitiveness of 10 Malaysian districts bordering Thailand. These variables were mainly related to the economic and socio-economic indicators. Each indicator was given a score between 0 and 3, with 3 being the highest (Refer Research Methodology section for detail explanation).

Table 1: Competitiveness index among 10 districts at the northern Malaysia's border

Malaysia's northern border State/ districts		Variables / Value (Score)					
		Non-citizen population ('000)	**Trade – export (Jan-Apr 2021) (RM million)**	**Trade – import (Jan-Apr 2021) (RM million)**	**Investment value (Domestic) of approved manufacturing project (RM'000)**	**Labour force ('000)**	**Working population ('000)**
Perlis		7.5 (3)	1,420 (2)	1,394 (2)	612,902 (2)	110.3 (3)	105.6 (3)
Kedah	Kubang Pasu	6.2 (3)	6,191 (2)	7,549 (2)	0	105.3 (3)	101.3 (3)
	Padang Terap	1.9 (2)	0	0	0	32.7 (2)	31.4 (2)
	Sik	2 (2)	0	0	0	32.4 (2)	31.4 (2)
	Baling	2.7 (2)	0	0	0	70.4 (2)	67.7 (2)
Perak	Hulu Perak	2.8 (2)	0	0	82,293 (2)	43.6 (2)	41.8 (2)
Kelantan	Jeli	1.6 (1)	0	0	0	19.3 (1)	18.7 (1)
	Tanah Merah	5.1 (2)	0	0	0	57.6 (2)	55.9 (2)
	Pasir Mas	4.6 (2)	0	0	0	81.4 (2)	77.6 (2)
	Tumpat	2.4 (2)	639 (1)	123 (1)	37,140 (1)	66.9 (2)	64.7 (2)
Mean		3.7	825	907	73,234	61.9	59.6
Standard Deviation		2.0	1,942	2,374	191,534	30.9	29.6

Cont.Table 1: Competitiveness index among 10 districts at the northern Malaysia's border

Malaysia's northern border State/ districts		Labour force participation rate (%)	Unemployment rate (%)	University graduates (citizen)	Average income (RM)	Absolute poverty rate (%)	Total Score
		Variables / Values (Score)					
Perlis		63 (2)	4.3 (1)	1617 (3)	5,476 (2)	3.9 (3)	**26**
Kedah	Kubang Pasu	61.8 (2)	3.9 (2)	1769 (3)	6,291 (3)	4.8 (3)	**26**
	Padang Terap	65.7 (3)	4 (2)	431 (1)	4,781 (2)	9.1 (2)	**16**
	Sik	61 (2)	3.1 (3)	395 (1)	4,960 (2)	7.6 (2)	**16**
	Baling	66.9 (3)	3.8 (2)	901 (2)	4,313 (2)	17.9 (1)	**16**
Perak	Hulu Perak	65.7 (3)	4 (2)	689 (2)	4,554 (2)	12.9 (2)	**19**
Kelantan	Jeli	57.1 (2)	3 (3)	288 (1)	3,872 (1)	18.5 (1)	**11**
	Tanah Merah	58.7 (2)	3 (3)	902 (2)	4,338 (2)	12 (2)	**17**
	Pasir Mas	54.8 (1)	4.6 (1)	1,586 (3)	4,745 (2)	13.1 (2)	**15**
	Tumpat	55.4 (1)	3.3 (2)	1,216 (2)	4,838 (2)	12.5 (2)	**18**
Mean		61.0	3.7	979	4,817	11.2	
Standard Deviation		4.4	0.6	544.7	673.3	4.9	

Source: Department of Statistics Malaysia (2021)

1. _Anggaran Pendapatan Isi Rumah dan Insiden Kemiskinan 2020_
2. _Jadual Statistik Perdagangan Malaysia Mengikut Negeri 2021_
3. _Laporan sosioekonomi Negeri Kedah, Kelantan, Perak and Perlis 2020_
4. _My Local Stats Perlis, Kubang Pasu, Padang Terap, Sik, Baling, Hulu Perak, Jeli, Tanah Merah, Pasir Mas and Tumpat_
5. _Perangkaan Perdagangan Luar Negeri_
6. _Pocket Stats Kedah, Kelantan Perak and Perlis Quarter 2 2021_

Based on the scores assigned to the variables, it was determined that Kubang Pasu and Perlis obtained the highest overall score with 26 points. Hulu Perak scored the second highest (19) followed by Tumpat (18). Meanwhile, Jeli scored the lowest competitiveness index with 11 points.

There is a significant development difference between the western (Perlis and Kedah), central (Hulu Perak), and eastern districts (Kelantan), with the western districts being more advanced. The western districts obtained the highest scores due to the concentration of manufacturing and service activities in these areas, as well as their role as logistics hubs. The Eastern districts, on the other hand, focus on agriculture and small-scale trading activities. The eastern districts of the border area have good potential for intensive and competitive agricultural and eco-tourism activities.

Additionally, the busiest entry points into Malaysia from Thailand, namely Bukit Kayu Hitam and Padang Besar, are located in the western districts. These immigration complexes handle over 90 percent of the trades passing through the Malaysia-Thailand border, with Bukit Kayu Hitam alone handling up to 65 percent of the total cargo. The Western districts of the border have the highest economic and socio-economic index due to their proximity to major industrial and urban areas in northern Peninsular Malaysia, such as Penang, Sungai Petani, and the bordering Songkhla province in Southern Thailand, which is the most industrialised among the four provinces bordering Malaysia. As the main industrial, logistics, and commercial hubs along the border, both Perlis and Kubang Pasu have more diversified economic activities, resulting in higher average incomes in these areas. Most high-impact projects are located in the western districts due to the availability of better infrastructure, including Immigration, Customs, Quarantine and Security (ICQS) complexes, as well as improved highway and rail systems.

Household incomes in the border areas are also lower than the national average, while the absolute poverty rates are much higher than the national rates (except for Perlis and Kubang Pasu). Kubang Pasu has an average income of RM6,291, which is nearly twice than that of Jeli, the district with the lowest average income of RM3,872. The average incomes in other districts range between RM4,000 and RM5,000. In terms of absolute poverty rates, the highest percentage was recorded in the middle of the border areas, specifically in Baling, Jeli, and Pasir Mas where the absolute poverty rates in these districts are two to three times higher than the national rate. These districts primarily rely on small-scale agriculture activities, which yield low returns. In fact, the absolute poverty rate of 18.5 percent in Jeli is nearly four times higher than that of Perlis (3.9 percent) and Kubang Pasu (4.8 percent).

Furthermore, the labour force participation rates at the border districts are lower than the national average. In other words, the number of working populations in the border districts is lower than the national average. Therefore, there is a need for a catalyst project to attract employment and higher income opportunities, especially for the locals. In terms of unemployment, the rate is almost equal to the national rate. However, Jeli and Tanah Merah recorded lower unemployment rates than other more industrialised areas in the western districts

CONCLUSION

This research provides valuable information on the overview of competitiveness in the international northern border districts of Peninsular Malaysia. The competitiveness index revealed the disparity among the districts along the Malaysia-Thailand border. By analysing eleven economic and socio-economic indicators, the study concludes that the western districts, specifically Perlis and Kubang Pasu, are more economically developed compared to the rural eastern districts like Baling, Jeli, and Tanah Merah. The economic diversity in Perlis and Kubang Pasu is attributed to their proximity to industrial areas such as Penang, Sungai Petani, and Songkhla in Southern Thailand. Additionally, the presence of the busiest entry points, Bukit Kayu Hitam and Padang Besar, contributes to the significance of logistics in these areas. Conversely, districts in the middle and eastern regions heavily rely on agriculture, resulting in lower average income and higher absolute poverty rates. The competitiveness index developed in this study aims to assist the government in formulating appropriate policies to address the developmental gaps in the Malaysia-Thailand border regions compared to other areas in Peninsular Malaysia.

REFERENCES

Department of Statistics Malaysia (2021). Anggaran Pendapatan Isi Rumah dan Insiden Kemiskinan 2020

Department of Statistics Malaysia (2021). Jadual Statistik Perdagangan Malaysia Mengikut Negeri 2021

Department of Statistics Malaysia (2021). Laporan sosioekonomi Negeri Kedah, Kelantan, Perak and Perlis 2020

Department of Statistics Malaysia (2021). My Local Stats Perlis, Kubang Pasu, Padang Terap, Sik, Baling, Hulu Perak, Jeli, Tanah Merah, Pasir Mas and Tumpat

Department of Statistics Malaysia (2021). Perangkaan Perdagangan Luar Negeri

Department of Statistics Malaysia (2021). Pocket Stats Kedah, Kelantan Perak and Perlis Quarter 2 2021

Economic Planning Unit (2015). Achieving a System of Competitive Cities in Malaysia Main Report. Putrajaya.

Gundersen F., Langeland O., & Aarhaug J. (2016). Work place location, transport and urban competitiveness: the Oslo case. *Transportation Research Procedia*. 26, pp.196–206

Harris N. (2007). "City Competitiveness." Research for the World Bank posted online by DPU Associates, London. http://www.dpu-associates.net/system/files/City+Competitiveness+09.pdf

National Academy of Economic Strategy & UNHABITAT (2020). *Global Urban Competitiveness Report* (2019-2020). Beijing, China and Nairobi, Kenya.

Sáez L. & Periáñez I. (2015). Benchmarking urban competitiveness in Europe to attract investment. *Cities*. 48. pp.76–85.

Sáez L. & Periáñez I., & Saizarbitoria I.H. (2017). Measuring urban competitiveness: ranking European large urban zones. *Journal of Place Management and Development. 10* (5). pp. 479-496.

Sgambati S. & Gargiulo C. (2022). The evolution of urban competitiveness studies over the past 30 years. A bibliometric analysis. *Cities*. 128. 103811

The World Bank Group (2015). Competitive Cities for jobs and growth – What, Who, and How. Washington, DC.

UNHABITAT & CASS (2020). *Competitiveness Report* (2019-2020). The World: 300 years of transformation into city. pp.5.

Received: 24th July 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 211 – 221

AN ASSESSMENT OF TRAFFIC CONGESTION IN TAMAN SRI SERDANG, SELANGOR, MALAYSIA

Afiq Haikal Fahmi[1], Syazwani Sahrir[2*], Nik Nor Rahimah Nik Ab Rahim[3]

[1,2,3] *Department of Environment,*
Faculty of Forestry and Environment,
UNIVERSITI PUTRA MALAYSIA

Abstract

The issue of traffic congestion has emerged as a significant and multifaceted challenge in numerous cities worldwide, encompassing substantial economic and environmental implications. Numerous experts have proposed that the foremost measure to address the congestion issue is to identify the characteristics of traffic congestion. This study aimed to assess the traffic congestion in urban road networks. Thus, the main methodological approach for conducting the study was the traffic volume study in Taman Sri Serdang, which was observed to examine the traffic flow during weekdays and weekends to examine the traffic flow patterns. Accordingly, conducting a traffic volume and Level of Service (LOS) analysis is necessary to enhance accessibility and road capacity. A comparison of the traffic trends and LOS during weekdays and weekends was also discussed. The findings concerning peak-hour traffic patterns are highlighted, and the conclusions are derived regarding urban traffic flow patterns.

Keywords: Traffic Volume Study, Level of Service (LOS), Traffic Congestion

[2] Lecturer at Universiti Putra Malaysia. Email: syazwani_sahrir@upm.edu.my

INTRODUCTION

Generally, traffic volume refers to the number of vehicles, density, and traffic capacity at a particular time and location. The traffic volume is influenced by socio-economic activities such as traffic growth, which causes traffic congestion during peak hours. Commercial and residential areas affect the number of vehicles of a traffic capacity and the overall traffic performance (Singh et al., 2021). The urban area might result in unmanageable and worse traffic conditions, such as congestion. This study focuses on Taman Sri Serdang, a focal area with mixed-use development such as commercial, residential, and institutional. In addition, Taman Sri Serdang is located next to one of the educational institutions, Universiti Putra Malaysia, and schools, which leads to traffic congestion. The economic activities in this area have also increased the amount of traffic.

The direct effect of the additional traffic volume from daily activities is a drastic increase in the traffic volume. This drastic increase caused an overflow of road capacity and resulted in a poor level of road service that could not accommodate the high traffic volume, especially in areas with low traffic capacity and higher population density (Kadim et al., 2020; Noor et al., 2021; Wan Ghazali et al., 2021). Traffic congestion usually occurs during peak hours when congestion is caused by road users going to and from work, school, institution, or any other place (Noor et al., 2021). This scenario worsens if the area is in a focal point such as Taman Sri Serdang. The development of an area has an impact on the increase in vehicles and the increase in traffic travel time delays.

In addition, the design of intersections, such as T intersections and intersections (four-legged intersections), affects the travel time of vehicles passing through the intersection (Kar et al., 2020). In addition, vehicles entering and exiting intersections, as well as the number of lanes, are factors that influence vehicle speed and travel time delays. Due to the increase in vehicles traversing the intersection, particularly during peak hours, travel time delays may increase. The town of Taman Sri Serdang, a focal area with various facilities such as commercial areas, public amenities, educational institutions, and others, causes the road to be busy on weekdays and weekends. Furthermore, Taman Sri Serdang's residential road is a shortcut to Sri Serdang town. Consequently, the road became congested as the area's residents parked their vehicles on the side of the road, which led to the congestion of the road.

LITERATURE REVIEW

Traffic Volume

Traffic volume studies determine the number of vehicle movements, road geometry, and road classification at a given location (Kadim et al., 2020; Rosli, 2020). The collection data of traffic volume study is vital to determine the influence of the number of vehicles on the traffic flow. These data also identify critical flow times such as peak hours and traffic volume trends. The sampling time duration depends on the type of count that is taken and the use of the data recorded. The traffic flow in the study area was recorded at 15-minute intervals for an hour at each intersection during a set time (Musir et al., 2018; Ponrahono et al., 2019). The sampling locations for the traffic volume study were usually identified, such as at junctions, non-signalised intersections, and significant points of potential traffic conflicts to conduct traffic counting during the peak hours of morning, noon, and afternoon. Understanding the traffic volume on roads facilitates infrastructure planning and design aids in determining the capacity of extant roads and identifies areas that are in need of improvements.

Level of Service (LOS)

The LOS is a quality indicator that describes the operating circumstances of a traffic stream in terms of speed, travel duration, traffic disruptions, and convenience (Farman Majeed Salam & Majid, 2022). The determination of LOS was also used based on the volume-to-capacity ratio (V/C) in a manually operated study under mixed traffic (Navandar et al., 2020). There are six levels of LOS from A to F; each level has specific flow, volume, density, and speed traffic conditions. LOS A represents the best operating condition, and LOS F represents the worst condition of traffic (Rosli, 2020).

Table 1: LOS and condition of traffic

Level of Service	Remarks
A	Free flow. Low volumes, densities, and high speeds. Drivers can maintain desired speeds with little or no delay.
B	Stable Flow. Traffic circumstances are beginning to limit operating speeds slightly. Slight delay.
C	Stable Flow. Higher volumes control speeds and manoeuvrability more precisely. Acceptable delay.
D	Approaching Unstable Flow. Tolerable operating speeds that are influenced by the operational environment. Tolerable delay.
E	Unstable Flow. Even lower working speeds, as well as possible short-term stoppages. Volumes are at or near capacity, causing traffic congestion and unacceptably long delays.
F	Forced Flow. Speeds and volume can be reduced to zero. Stop pages might last for a long time. Vehicle queues backed up due to a restriction downstream

Source: Public Works Department (PWD)(2017)

The LOS also represents a range of operating conditions and the driver's perception of those conditions, and it is used to measure the level of vehicle delay time and the level of traffic congestion (Ali Sahraei & Akbari, 2020; Farman Majeed Salam & Majid, 2022; Kar et al., 2020). Therefore, the LOS is one of the most popular traffic performance metrics. It can be divided into six levels based on traffic density: A (free flow), B (reasonably free flow), C (stable flow), D (approaching unstable flow), E (unstable flow), and F (forced or breakdown flow) (refer to Table 1).

Traffic Congestion

Traffic congestion directly impacts the quality of life as most people experience daily difficulties with excessive delays, air pollution, and health. Traffic congestion causes negative impacts on the transport sector and causes a massive increase in the transportation cost. Thus, the encounter of traffic in conflict points at intersections affects traffic movement in terms of speed, traffic volume, and traffic density, causing traffic congestion (Eva & Andrea, 2019). Moreover, the increase in traffic volume and vehicle density also affects the probability of traffic congestion occurring in an area.

RESEARCH METHODOLOGY

Study area

The study area in Taman Sri Serdang is a mixed-use development area that is located in the heart of Seri Kembangan, Selangor, Malaysia (refer Figure 1). The residential areas, public amenities, and educational institutions such as Sekolah Kebangsaan Serdang and UPM influence the increase in traffic in this area. As such, this research uses both primary and secondary data sources.

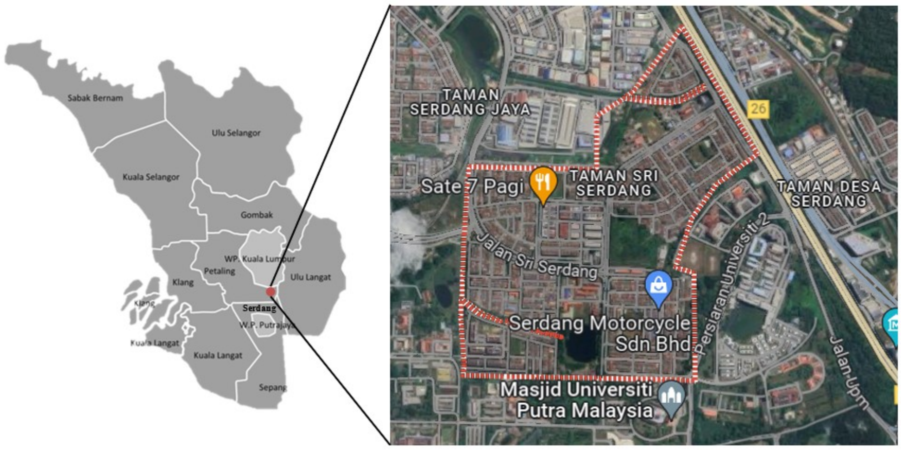


Figure 1: Study area of Taman Sri Serdang

Traffic Counting and Survey
Traffic calculation is carried out for three (3) days of traffic calculation on weekdays and one (1) weekend. All the traffic data is grouped into three phases: morning peak (7-9 am), afternoon peak (12-2 pm), and evening peak (4-6 pm), and each peak continues for a period of 2 hours. Accordingly, the record traffic volume counts are at 15-minute intervals using a calculation sheet.

Passenger Car Unit (PCU)
The calculation of PCU is essential to analyse mixed or heterogeneous traffic. PCU is a simplification that converts the different vehicle types into an equivalent number of passenger cars (Mohan & Chandra, 2018). According to the Public Work Department, the urban standard of Passenger Car Unit (PCU) metric was used to assess the traffic flow and traffic volume of the study area in Sri Serdang. The value of PCU equivalent for urban standard roads is taken as 1.0 for cars (4-wheelers), 0.75 for motorcycles (2-wheelers), 3.0 for bus/lorry, and 0.2 for bicycles (Ponrahono et al., 2019).

Level of Service (LOS)
A standard LOS from the Public Works Department of Malaysia is used to assess the LOS of road service in the study area at Taman Sri Serdang, as shown in Table 2.

Table 2: Level of service by volume/capacity ratio

Volume/Capacity Ratio	Traffic Flow	Level of Service
0.0 – 0.2	Free flow	A
0.2 – 0.4	Free flow but close to stable flow	B
0.4 – 0.6	Stable flow	C
0.6 – 0.8	Stable flow but close to congested	D
0.8 – 1.0	Congested	E
More than 1.0	Very congested	F

Source: Public Works Department (PWD)(2017)

RESULTS AND DISCUSSION
Traffic Volume
Traffic counts were conducted to determine the traffic volume trends and study area patterns. Traffic is counted and recorded for six (6) hours from 7.00 am to 9.00 am, 12.00 pm to 2.00 pm, and 4.00 pm to 6.00 pm for three days on weekdays, and one day on weekends. The traffic calculation radius is set to a diameter of 100 meters from the sampling point. The change in traffic volume by the hour (Table 3) from Taman Sri Serdang to the highway shows that the maximum number of vehicles passing through the junction is 1,255 between the

hours of 4.00 pm to 6.00 pm (Wednesday), and the minimum number of vehicles passing through the junction is 708, between 7.00 am to 9.00 am (Sunday).

Table 3: Hourly Traffic Volume Taman Sri Serdang to PLUS Highway

Count Hour	Monday	Wednesday	Saturday	Sunday
7.00 am-9.00am	956	957	680	708
12.00 pm-2.00 pm	1143	1151	862	951
4.00 pm-6.00 pm	1217	1255	943	982
TOTAL	3316	3363	2485	2641

Source: Field Survey

Meanwhile, the amount of traffic from UPM to Sri Serdang (Table 4) shows that the maximum number of vehicles that have been observed through the intersection is 1,257 from 7.00 am to 9.00 am (Monday), and the minimum number of vehicles is 756 vehicles from 7.00 am to 9.00 am (Sunday).

Table 4: Hourly Traffic Volume UPM to Seri Kembangan

Count Hour	Monday	Wednesday	Saturday	Sunday
7.00 am-9.00am	1257	1080	806	756
12.00 pm-2.00 pm	1083	1042	924	954
4.00 pm-6.00 pm	1244	1261	1082	994
TOTAL	3584	3383	2812	2704

Source: Field Survey

24 Hours Count of Traffic Flow

A 24-hour traffic count observation shows the number of vehicles that are passing through Jalan UPM to Seri Kembangan and Taman Sri Serdang to PLUS Highway. Table 5 shows the cumulative 24-hour traffic flow count for weekdays and weekends. The number of vehicles that pass through UPM to Seri Kembangan is higher because the road provides services such as oil pumps, government institutes, police stations, and schools. Thus, of the 14,719 vehicles that have been recorded throughout the weekdays and the weekend, about 12,795 vehicles have passed through Taman Sri Serdang to the highway. The average vehicle is 613.29 vehicles per hour. In contrast, the number of vehicles on the UPM road to Sri Serdang is 13,111 (refer to Table 5).

Overall, the highest transport that passes through Taman Sri Serdang is cars, followed by motorcycles. This is due to the lack of public transport services such as bus transport as well as being far from the services of other public transport facilities. The nearby residential area also contributes to the daily traffic flow around the entrance to Taman Sri Serdang. Notably, the number of bicycles is the lowest among all the transportation types. This is due to the absence and lack of bicycle access, such as bicycle paths. The safety factor also contributes to the small number of bikes that are using the access road in Sri Serdang.

Table 5: Hourly Traffic Volume UPM to Seri Kembangan

	Taman Sri Serdang -PLUS Highway	UPM-Seri Kembangan
Car	8204	8253
Motorcycle	4247	4573
Bus/Lorry	324	279
Bicycle	20	6
TOTAL	12795	13111

Source: Field Survey

Peak Hour PCU

The maximum PCU, as in Table 6, is 12365.25 in the direction from Taman Sri Serdang to the highway, and the minimum PCU is 12,520.95 in the direction of UPM to Seri Kembangan.

Table 6: Cumulative hour count of PCU

	Taman Sri Serdang -PLUS Highway	UPM-Seri Kembangan
Car	8204	8253
Motorcycle	3185.25	3429.75
Bus/Lorry	972	837
Bicycle	4	1.2
TOTAL	12365.25	12520.95

Source: Field Survey

Table 7 summarises the PCU peak hours. The maximum vehicle count is 1,288 vehicles from UPM to Seri Kembangan from 4.00 pm. to 6.00 pm (Thursday), while the minimum vehicle count is 756 vehicles from UPM to Seri Kembangan from 7.00 am to 9.00 am (Sunday).

Table 7: Peak hour PCU

Direction	Period	Vehicles/2hours	PCU/2hours
Taman Sri Serdang – PLUS Highway	Maximum traffic Wednesday 4.00 pm-6.00 pm	1255	1202.2
	Minimum traffic Sunday 7.00 am-9.00am	708	653.75
UPM – Sri Kembangan	Maximum traffic Thursday 4.00 pm-6.00 pm	1288	1211.25
	Minimum traffic Sunday 7.00 am-9.00am	756	691.75

Source: Field Survey

Level of Service (LOS)

The volume/capacity ratio is calculated, and the LOS is based on the peak-hour service. The LOS for the direction from Taman Sri Serdang to the highway between LOS B to C shows a free flow but there is a close to stable or stable flow to road capacity during peak hours. However, the direction from UPM to Seri Kembangan (Table 8) shows a LOS between LOS B to D and congested during peak hours.

Table 8: Level of service

Direction	Time	Peak Hour Traffic in PCU/2hours	V-C ratio	Level of Service (LOS)
Taman Sri Serdang to Highway	Maximum traffic Wednesday 4.00 pm-6.00 pm	1202.2	0.60	C
	Minimum traffic Sunday 7.00 am-9.00 am	653.75	0.33	B
UPM to Sri Kembangan	Maximum traffic Thursday 4.00 pm-6.00 pm	1211.25	0.61	D
	Minimum traffic Sunday 7.00 am-9.00 am	691.75	0.35	B

Source: Field Survey

The opening of several economic sectors and basic facilities such as schools and police stations are the main factors in the increase in traffic. The types of intersections that are uncontrolled or do not have signals have contributed to the increase of LOS values from LOS B to LOS D, where traffic congestion occurs. The lack of intersections that are not controlled or do not have signals causes an increase in vehicle travel delay time, where drivers must be careful and take a long time to wait to enter or exit the intersection (Mohan & Chandra, 2018). This causes congestion caused by vehicles entering or exiting the intersection, where drivers must slow down and stop to make way for other vehicles. The increase in the density of cars on the road causes the speed of vehicles to slow down, and the capacity of the road is insufficient. Following a significant increase in traffic flow over the weekend, severe traffic congestion has reached LOS D. This follows that the Taman Sri Serdang area has various facilities that cause Sri Serdang to become an area where individuals focus on social activities. Thus, to increase the road's capacity and LOS, engineers and planners can consider modifying the parameters in traffic composition and junction balance (Rosli, 2020).

As the population of Taman Sri Serdang has increased, the traffic has also increased. Moreover, the size of urban areas and the type of roads determine how congested a place is (Nguyen-Phuoc et al., 2020). In addition, the absence of bus service routes in some areas, especially in the residential zones, has caused the reception of bus services in Taman Sri Serdang to be less than satisfactory. In response, the responsible parties need to improve the quality of bus services to increase the public demand for these services. A quality bus service can minimise the public's demand for private vehicles (Buchanan, 2019) as well as the increasing traffic in the Sri Serdang area. Alternatively, residents of the Sri Serdang area can use the UPM MRT facility to go to their desired destination to reduce the number of vehicles on the road.

Installing speed humps can also reduce and slow down the vehicle's speed. This method can potentially reduce the risk of road accidents by increasing the driver's awareness to be more careful. Considering the high traffic flow in Taman Sri Serdang, installing road humps near the intersection is ideal. At the same time, installing speed bumps also reduces traffic congestion at uncontrolled or unsignalised intersections.

CONCLUSION

In conclusion, Taman Sri Serdang has a mixed-use development that caused an increase in traffic in Taman Sri Serdang and a change in the level of service. The level of the LOS was calculated for the main road of Sri Serdang between levels B and D. Basically, the intersections that are without signals make it difficult for vehicles to enter and exit the intersections. The large number of vehicles causes vehicles to wait in order to enter and exit the intersection. The disadvantage of unsignalised or uncontrolled intersections is that they can increase the risk of accidents and congestion. Proposals to improve the public transport system in Sri Serdang are needed to accommodate vehicle capacity and reduce the number of vehicles on the main road. Furthermore, installing a speed hump in a suitable location in Taman Sri Serdang can reduce the speed of vehicles as well as the risk of accidents in places that do not have signals or that are not controlled. The problem can be resolved by controlling pedestrian free flow and vehicle increasing rate, enhancing public transport modes, repairing traffic signals and providing pedestrian walkways, regulating vehicular flow through traffic management, and strictly enforcing traffic laws.

REFERENCES

Ali Sahraei, M., & Akbari, E. (2020). Review and evaluation of methods for estimating delay at priority junctions. *Australian Journal of Civil Engineering*, *18*(2), 126–139. https://doi.org/10.1080/14488353.2020.1743591

Buchanan, M. (2019). The benefits of public transport. *Nature Physics*, *15*(9), 876. https://doi.org/10.1038/s41567-019-0656-8

Eva, P., & Andrea, K. (2019). Determination of priority stream volumes for capacity calculation of minor traffic streams for intersections with bending right-of-way. *Transportation Research Procedia*, *40*, 875–882. https://doi.org/10.1016/j.trpro.2019.07.123

Farman Majeed Salam, & Majid, A. prof. D. H. M. (2022). Evaluation of Capacity and Level of Service for Heterogeneous Traffic of Urban Multi-Lane Highways. *Construction*, *2*(2), 31–38. https://doi.org/10.15282/construction.v2i2.8609

Kadim, Z., Johari, K. M., Samaon, D. F., Li, Y. S., & Hon, H. W. (2020). Real-Time Deep-Learning Based Traffic Volume Count for High-Traffic Urban Arterial Roads. *ISCAIE 2020 - IEEE 10th Symposium on Computer Applications and Industrial Electronics*, *C*, 53–58. https://doi.org/10.1109/ISCAIE47305.2020.9108799

Kar, M., Jena, S., Chakraborty, A., & Bhuyan, P. K. (2020). Modelling Service Quality Offered by Signalized Intersections from Automobile Users' Perspective in Urban Indian Context. *Transportation Research Procedia*, *48*, 904–922. https://doi.org/10.1016/j.trpro.2020.08.109

Mohan, M., & Chandra, S. (2018). Three methods of PCU estimation at unsignalized intersections. *Transportation Letters*, *10*(2), 68–74. https://doi.org/10.1080/19427867.2016.1190883

Musir, A. A., Ramli, M. Z., Ramlee, R., Abdullah, N. H. H., Albar, A., Hasan, D., & Dollah, Z. (2018). An analysis of traffic flow and control for road safety audits at Jalan Berapit (State Route P131) Bukit Mertajam, Pulau Pinang. *AIP Conference Proceedings*, *2030*(May 2022). https://doi.org/10.1063/1.5066878

Navandar, Y. V., Dhamaniya, A., & Patel, D. A. (2020). Headway distribution for manually operated tollbooths in India in mixed traffic conditions. *Proceedings of the Institution of Civil Engineers: Transport*, *173*(1), 30–38. https://doi.org/10.1680/jtran.17.00138

Nguyen-Phuoc, D. Q., Young, W., Currie, G., & De Gruyter, C. (2020). Traffic congestion relief associated with public transport: state-of-the-art. *Public Transport*, *12*(2), 455–481. https://doi.org/10.1007/s12469-020-00231-3

Noor, M. A., Ashrafi, S., Fattah, M. A., Morshed, S. R., & Rahman, S. (2021). Assessment of traffic congestion scenario at the CBD areas in a developing city: In the context of Khulna City, Bangladesh. *Transportation Research Interdisciplinary Perspectives*, *11*, 100435. https://doi.org/10.1016/j.trip.2021.100435

Ponrahono, Z., Isa, N. M., Aris, A. Z., & Harun, R. (2019). The traffic volume and level of service (LOS) of universiti putra Malaysia (UPM) serdang campus main access. *Planning Malaysia*, *17*(2), 50–61. https://doi.org/10.21837/pmjournal.v17.i10.628

Public Works Department (PWD). (2017). *ATJ 11-87 (Pindaan 2017) A Guide to Design of At-Grade Intersection*. Ibu Pejabat JKR Malaysia.

Rosli, M. D. (2020). *Evaluation on the Performance of Signalised Roundabout At Bulatan Seksyen 15, Bandar Baru Bangi, Selangor*. Universiti Teknologi Malaysia.

Singh, D., Ameen, T., & Ahmad, A. (2021). Analysis of delay and queue length variation at three-leg signalized intersection under mixed traffic condition. *Innovative Infrastructure Solutions*, *6*(2). https://doi.org/10.1007/s41062-021-00493-1

Wan Ghazali, W. N. W., Ponrahono, Z., Bachok, S., Sharaai, A. H., Rabe, N. S., Mat Shukri, N. S., & Sunoto, Y. N. (2021). Travel Mode Choice Intention in Reducing Traffic Congestion in Kajang, Selangor. *Planning Malaysia*, *19*(4), 269–279. https://doi.org/10.21837/pm.v19i18.1051

Received: 26th June 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 222 – 236

DETERMINANTS OF SPATIAL PLANNING FOR URBAN RESILIENCE IN THE ISLAMIC SOCIETY SETTING: A CASE STUDY OF BANDA ACEH, INDONESIA

Evalina Zuraidi[1], *Rosilawati Binti Zainol[2], Yahaya Bin Ahmad[3], Ashfa Achmad[4]

[123] *Faculty of Built Environment,*
UNIVERSITI MALAYA
[2]*Centre for sustainable urban planning and real estate (SUPRE), Department of Urban and Regional Planning, Faculty of Built Environment,*
UNIVERSITI MALAYA
[2]*Centre for Transport Research,*
UNIVERSITI MALAYA
[2]*Centre for Civilisational Dialogue,*
UNIVERSITI MALAYA
[14]*Department of Architecture and Planning,*
UNIVERSITAS SYIAH KUALA, INDONESIA

Abstract

The paper identifies the determinants influencing spatial planning for urban resilience within the context of an Islamic society. Semi-structured interviews were conducted with relevant stakeholders in spatial planning and disaster management in the city of Banda Aceh, Indonesia to assess their attitudes, opinions and experiences in implementing spatial planning for urban resilience. Qualitative thematic analysis revealed dominant factors specific to the Islamic society in the city of Banda Aceh, which were then elaborated on and categorised into five major groups: spatial pattern, spatial structure, spatial culture, spatial-related non-physical factors and religious factors. The interviews affirmed the importance of religious and cultural factors in spatial planning for urban resilience within Islamic societies. The findings will provide an essential understanding of the need to enhance urban resilience against disasters in the urban planning process and incorporate aspects of local wisdom derived from religious and cultural values, as well as societal necessities, as a planning approach. Given the context-specific nature of this research, future researchers may consider doing a comparative case study in another city with similar characteristics.

Keywords: Spatial planning, Urban Resilience, Islamic society, Thematic Analysis, Banda Aceh- Indonesia

[2] Corresponding author Email: rosilawatizai@um.edu.my

INTRODUCTION

Since the previous century, there has been a notable increase of global disaster frequency, particularly in Asia, which is particularly susceptible to natural disasters. The UN Environment Program (UNEP) reports that Asia accounted for 40% of global natural disasters between the years of 2005 and 2015 (Lee, Kim, Maharani, Paripurno, & Sunarno, 2017). Tragic events like the 2004 tsunami and earthquakes in Indonesia and the Indian Ocean claimed the lives of hundreds of thousands (Folke et al., 2011), with profound repercussions on neighbouring countries such as Indonesia, Sri Lanka, India, and Thailand. The nearest big city, Banda Aceh in Aceh Province, Indonesia, bore a severe number of victims and witnessed the destruction of 27% of its 60.33km2 area. The toll in terms of lives lost and injuries incurred amounted to approximately 27 thousand people from a population of 243,895 in the city (Government of The City Banda Aceh, 2018).

Given the escalating historical losses from disasters worldwide, resilience is increasingly recognised as a fundamental principle, as many acknowledge that massive losses result from a lack of urban resilience systems in effectively managing disasters (Achmad, Burhan, Zuraidi, & Ramli, 2020; UNDRR, 2015). Most professional disciplines, such as spatial planning and disaster risk management, began to realise the importance of playing a vital role in planning and establishing resilient urban systems (Hoa & Vinh, 2018). Notably, international policies underline the importance of integrating disaster risk reduction, resilience and climate risk considerations into urban planning to achieve sustainable development at various levels, including Sustainable Development Goals (SDGs) and the Sendai Framework for Disaster Risk Reduction 2015–2030 (UNDRR, 2015).

The literature affirms that the integration of these two fields presents a significant challenge. Wamsler (2014) notes that spatial planners may not prioritise risk reduction as a planning objective, and communication between experts from both fields is hindered by differences in their target groups, objectives, data sources and educational and professional backgrounds. Simultaneously, disaster studies tend to neglect spatial planning as an essential risk reduction measure (Sagar, 2017). Moreover, each authority operates within a different institutional framework with its unique operational methods and designated funding purposes (Greiving & Fleischhauer, 2006). Additionally, as highlighted by Zuraidi, Zainol, Ahmad, & Achmad (2022), most studies concerning spatial planning and urban resilience have been conducted in developed Western countries. Therefore, the general consideration of disaster risk reduction through enhancing urban resilience in spatial planning practices is questionable, especially in cities with specific characteristics such as those within Islamic societies.

A critical aspect lies in recognising that the experiences of spatial planning and urban resilience can markedly differ between developing Asian countries and Western contexts. It is essential to understand how these concepts are interpreted and experienced. This nuanced understanding can be achieved through a robust qualitative methodology. Therefore, this research collects insights from stakeholders in spatial planning and disaster-related fields in Banda Aceh, Indonesia, exploring their perspectives and experiences in enhancing urban resilience. The qualitative exploratory research was subsequently subjected to thematic analysis, aiming to identify the determinants of spatial planning for urban resilience.

LITERATURE REVIEW

The notion of urban resilience has gained considerable attention in planning discourse over recent decades. Its origins trace back to in the study of ecological systems drawn from the work of C.S. Holling entitled “Resilience and stability of ecological systems” (Holling, 1973). Subsequently, in the early 2000s, scholars extended the concept of resilience into regional and urban planning practices, incorporating elements of disasters as essential elements in the planning process (Godschalk, 2003). Explicit references to spatial planning concepts and urban resilience began to emerge in the 2010s. Until now, the existing works of literature on spatial planning for urban resilience predominantly address topics related to urban physical structure and governance (Malalgoda, Amaratunga, & Haigh, 2013; Panagopoulos, Jankovska, & Bostenaru Dan, 2018). However, very little research in this area has explored spatial planning for urban resilience with a focus on the socio-religious perspective. The literature indicates that transitioning to a resilient urban community hinges on a multitude of factors, and cultural and site-specific parameters can pose challenges to broad-spectrum approaches.

Spatial planning is primarily acknowledged as a function of the public sector aimed at influencing the future spatial distribution of activities (Yoshida, Yamagata, Chang, Jittrapirom, & Voulgaris, 2020). Its goal is to establish a more rational territorial arrangement of land use and their interconnections, striking a balance between developmental demands and environmental protection, while also achieving social and economic objectives (Wegener, 1998). Meanwhile, Meerow, Newell, & Stults (2016) defined urban resilience as “the ability of an urban system—and all its constituent socioecological and socio-technical networks across temporal and spatial scales—to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity” (p. 45). Rogatka, Starczewski, & Kowalski (2021) also emphasised that urban resilience is a superior concept that must be considered in future spatial planning endeavours, as it is integral to shaping appropriate urban development.

Previous studies have identified several determining factors in spatial planning for urban resilience. Lu, Zhai, Zhou, & Shi (2020) advocate for a focus on essential urban spatial elements to create urban resilience, including key spatial and morphological factors, which encompass factors like urban spatial scale, urban spatial form, urban spatial structure, urban spatial function and urban spatial network. Other studies focus on non-physical aspects such as policies, actors, socioeconomics, genius loci and information (Ewindy, Suganda, Asdak, & Sapari, 2021; Karabakan & Mert, 2021; Nur, 2020; Pokhrel, 2019; Pozoukidou, 2020; Rogatka et al., 2021; Mazlan, Zainol, Adilah, & Harumain, 2022).

Studies related to spatial planning for urban resilience within the socio-religious context is limited. Existing research predominantly emphasises the important role of religion in strengthening individual resilience in facing disasters. Resilience related to the concept of religion establishes a connection between people, practices, materials and spatial infrastructure with disaster events (Rüpke, 2020). This concept acknowledges the anticipation of disasters, the pre-event anxiety, strengthening individuals and communities against the event, and providing a prompt response after the event. It illustrates how faith is employed to overcome, recover and grow (Sulaiman, She, & Fernando, 2019). Gianisa & Le De (2018) also found that religious beliefs and practices unite local communities and contribute to the effectiveness of disaster management mechanisms. Moreover, religious communities can play a vital role in bridging gaps in response and recovery, especially in scenarios where external intervention is limited.

RESEARCH METHODOLOGY

This research was conducted in the city of Banda Aceh, Indonesia (Figure 1). Banda Aceh is a medium-sized city characterised by its vulnerability to natural disasters, and its population is predominantly Muslim. In 2004, the city experienced a catastrophic earthquake, swiftly followed by a devastating tsunami. This twin disaster resulted in the destruction of 27% of city's 60.33km2 area, rendering it devoid of buildings. Casualties and fatalities numbered approximately 27,000 out of the 243,895 residents of Banda Aceh City (Aceh Province Disaster Management Agency, 2018).

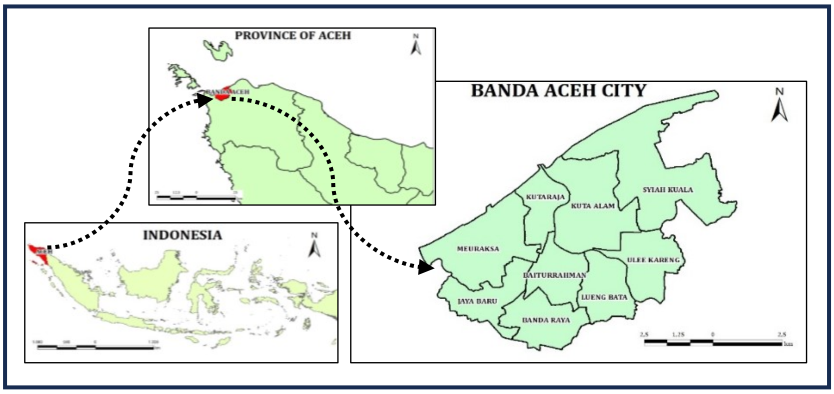


Figure 1: Study Area: the city of Banda Aceh, Indonesia
Source: Author, 2023

Semi-structured interviews were conducted with ten relevant stakeholders to assess their perspectives, insights and experiences in the process and implementation of spatial planning for urban resilience within the context of an Islamic society. These participants were selected from individuals representing government and non-government institutions, possessing substantial knowledge and experience in spatial planning and disaster management in Banda Aceh. Prior to starting the research, all documents and procedures concerning human subjects were approved by the University of Malaya Research Ethics Committee (UMREC), with ethics approval number: UM TNC2/UMREC_1876. Researchers extended invitations to stakeholders via telephone or WhatsApp, ensuring their willingness to participate. Prospective participants received an information sheet outlining the purpose of the research. All participants met the criteria of being cognitively functional and above 18 years of age. The interview guide focused on eliciting stakeholders' perceptions regarding the determining factors in spatial planning conducive to urban resilience. The interviews spanned a duration of 30 to 45 minutes and were transcribed verbatim from audio recordings, maintaining an exact account of the discussions.

The data was then analysed using a thematic analysis (TA) methodology in accordance with the approach advocated by Clarke & Braun (2017). TA is a method for identifying, analysing and reporting patterns (themes) within data, where a theme is defined as "something important about the data in relation to the research question and represents some level of patterned response or meaning from the data set" (p. 80). This study followed a six-phase thematic data analysis process developed by (Clarke & Braun, 2017). The first phase involved 'Familiarizing yourself with your data', where the interview transcripts were read and re-read, allowing the researcher to note initial ideas. Interview transcripts were then imported into the data management software NVivo. The second phase," Generating initial codes", encompassed a descriptive coding process that involved the deconstruction of the data from its initial chronological structure. This inductive process resulted in the identification of 407 hierarchical codes from the interview data. In the third phase, "Searching for themes", open coding was reviewed, and initial codes were merged, renamed, distilled and collapsed into broader categories. This allowed the data to be constructed in a manner aligned with the research objectives. The fourth phase, "Reviewing themes", involved a process of 'drilling down', including recoding the text in the initial codes, reorganising them into a coding framework and breaking down the themes into sub-codes to gain a better understanding of the embedded meanings. In the fifth phase, "Defining and naming themes", the data was abstracted into a broader thematic framework. Through an inductive process, data was coded in relation to the research objective, which is to identify determinant factors of spatial planning for urban resilience. The final phase, "Producing the report", involved the writing of analytical memos to accurately summarise the content of each theme and propose empirical findings.

RESULTS AND DISCUSSION

All participants in this are university graduates with a minimum of ten years of experience in their respective fields. Their ages range from 35 to 55 years. Of the ten stakeholders interviewed, six were male (60%) and four were female (40%). The sample is well-balanced in terms of representation from different stakeholder types, where four (40%) are experts in spatial planning, four (40%) specialise in disaster, and two (20%) focus on community culture. The range of professional experience among the participants is diverse. Participants with over 25 years of experience make up 20% of the sample, while those with 10-15 years and 20-25 years of experience constitute 20%. The group with 15-20 years of experience accounts for 40% of the sample size. In terms of employment sectors, six participants (60%) work in the public sector, while the remaining four (40%) are employed in the private sector.

Through inquiries into determinants of spatial planning for urban resilience, the study identified dominant factors specific to the Islamic community in Banda Aceh. These factors were subsequently detailed and grouped into five main themes derived from the thematic analysis: (1) spatial pattern, (2) spatial structure, (3) spatial culture, (4) non-physical factors related to space and (5) religious factors. Table 1 provides a summary of the themes and sub-themes generated from the initial coding process and excerpts from the interview transcripts.

The 'spatial pattern' theme was generated from 73 coding from 10 participants. The 'spatial structure' was generated from 6 participants and 32 coding. The 'spatial culture' was generated from 7 participants and 23 coding. The 'spatial related non-physical factors' theme resulted from 10 participants and

407 comments, and the "religious factors" theme was derived from 10 participants and 76 comments. Spatial pattern factors were identified from the sub-themes of spatial scale and spatial use. Spatial scales, such as the size of urban spaces and the growth of urban development, are determining factors in urban spatial planning and its resilience to disasters. This aligns with the findings of previous research by Lu et al. (2020), which states that urban spatial scale wields both positive and negative effects on resilience. On the positive side, larger cities often possess more efficient and resource-independent infrastructure, rendering them more resilient to economic crises and adept at swift recovery (Capello, Caragliu, & Fratesi, 2015). However, when urban development exceeds its ecological carrying capacity, the large urban spatial scale can exert a negative impact on resilience. Functional complexity and specialization grow with increasing city scale, potentially reducing overall resilience.

Table 1. Themes generated on spatial planning for urban resilience determinants.

Themes	Sub-Themes	NOC	NOP	Initial codes	Verbatim Data Extract Samples	PI
Spatial pattern	Spatial use	69	10	Physical Infrastructure, Land Use, Workplace, Nature-Based Solution	*"In the aspect of resilience referred to earlier, there should be a determination of land use management directed at tsunami mitigation if we talk about the tsunami context."*	SH 03
	Spatial scale	4	2	City Size, Urban Growth, Urban Function	*"Banda Aceh is small enough to be controlled…We can make it more compact for a system of activities that makes it more concentrated and robust."*	SH 09
Spatial structure	Spatial structure	21	4	Service Center System, Node System, Activity Center System, Ring Road	*"We have activity and service centers tiered directly from the sub-center to the neighbourhood center. Now, this neighborhood center can function as a center that provides all kinds of things. So, we have the potential to create a more resilient urban system"*	SH 09
	Spatial network	5	4	Transportation System, Urban Network System	*"In spatial planning, we also have to regulate how urban network systems, both transportation and service centers, pay attention to disaster aspects"*	SH 03
	Spatial form	5	3	Geographical Aspect, Urban Morphology	*"So now it is more like partial. We need to look at the morphology of the city, the water cycle so that it fits the aesthetic."*	SH 08
Spatial culture	Spatial culture	23	7	Inheritance, Silo Mentality, Local Wisdom, Gated Community, Place Connectedness, Disaster Amnesia	*"Our people have built a perception since ancient times that if any disaster occurs, including war, the place of refuge is the mosque (place of worship). If we want to build an escape building, we unite it with the concept of local wisdom of the community; if there is a disaster, the community remains run to the mosque, we make the mosque an escape building, the default is an escape building"*	SH 06
Spatial-related non-physical factors	Actors	10	6	University's Role, Ulama Involvement, Interaction Between Parties, City's Leader	*"This is not only the government's responsibility; all parties must work together to build resilience, including NGOs, academics, researchers, the business world, and the media. All play a role in building resilience together because this is a continuous task and must be awakened."*	SH 04
	Economic	22	8	Budgeting, Financial Issues, Economic Interest, Livelihood, Compensation	*"Well, most people choose a place to live for reasons, firstly, because it is close to their work location and source of income. Second, because land prices are low there, the rent is cheap. Then it is also close to family. So those factors make them finally (living there). So, no wonder the tsunami areas are now getting crowded."*	SH 04

Themes	Sub-Themes	NOC	NOP	Initial codes	Verbatim Data Extract Samples	PI
	Evacuation systems	26	7	Community Centre, Evacuation Building, Meeting Point, Artificial Hill, Relocation	*"If resilience increases, we must also appreciate it. On the one hand, Banda Aceh City already has evacuation routes, evacuation signs, the determination of gathering points, and the designation of high, medium, and low-risk areas, although this does not reflect spatial planning or spatial planning practices. So, at least, that is what we saw."*	SH 03
	Information	47	9	Socialization, Information, Knowledge, Literacy	*"So, there is a transfer of information between generations with the formal and informal education system; that is the best that can be done."*	SH 03
	Institutions	77	9	Community Forum, Institutional Strengthening, Empowering, Government's Vision	*"Institutionally, we have Disaster Risk Management Forum (FPRB), a disaster resilient youth. However, I think we have to empower it and provide more capacity building; how do we get these forums to provide input, and do their functions run well? Not bad for our institutions; maybe that is potential. Institutional potential up to the village level, we have a disaster-resilient village. At least there is risk knowledge, and we have the institution that must be activated, whether running or not."*	SH 09
	Land related matters	28	6	Land Acquisition, Land Consolidation, Land Ownership, Land Use Change, The Land Value	*"There is a determination of land use management directed at tsunami mitigation if we talk about the tsunami context. There has been a change in land use converted into a buffer zone. In my opinion, it needs to be reviewed, and it needs to be considered to arrive at the resilient city definition."*	SH 03
	Policies	110	10	Planning Policy, Regulatory Compliance, Zoning Regulation, Risk-Oriented Policy, Policy Strategy	*"If we talk about policies, compared to other regions, it is quite advanced. Some regulations have been issued related to disaster risk reduction, and specifically, regarding the tsunami, both at the level of governor regulations, qanuns, and up to mayoral regulations. However, the focus is enforcement, and now enforcement is sometimes a weak side that we cannot see in practice so that this interaction will form the resilience profile together."*	SH 03

Themes	Sub-Themes	NOC	NOP	Initial codes	Verbatim Data Extract Samples	PI
	Social	80	10	Social Capital, Resistance, Public Involvement, Community Distrust, Community Education	*"The definite potential is social. Socially, our society is quite resilient. From the old war to the economic crisis in the 2000s, we were quite resilient. After that, after the tsunami, we already had risk knowledge. It was in people Aceh exists."*	SH 09
Religious factors	Religious belief	5	4	Belief in Allah, Surrender to Allah, Worship to God, Faith	*"JICA (Japan) and Banda Aceh learn from each other. They have the technology; we have some social values. For example, the ability to rise; they think we are better than them. We are stronger because there is a factor of religious belief. That is potential."*	SH 10
	Religious practice	37	9	Friday Sermon, Spatial Policy Setting with the Shari'a, Evacuation to Masjid, Syariah Awareness, the Role of Ulama (Cleric), Religious Behaviour	*"We have a spiritual based mitigation strategy. Disaster mitigation is not only what we need physically; we also build non-physically. If we strengthen spirituality and calm a few people's minds to think, they must pray, they will recite; this is Allah's test. We will build an escape building on a spiritual basis, namely Masjid. We use local wisdom, combining wisdom with faith and technology; our culture is Islamic. Then, Friday pulpit, a straightforward public space, that the verses of the Quran talk more about disasters"*	SH 02
	Religious knowledge	27	7	Religious Teaching, Islamic Concept, Rationality, Inclusiveness	*"Actually, in the Quran, it says we must stay away from danger, but at that time, residents did not know, they thought it was the end of the world, so they went to the mosque, and it was fatal."*	SH 10

Note: NOC= Numbers of Comments, NOP= Numbers of Participants, PI= Participant Identifier

Source: Author (2023)

Furthermore, within the spatial pattern, the sub-theme of spatial use also emerges as a determining factor. The study found that the allocation of space for physical infrastructure, the availability of supporting facilities, and the utilisation of land for settlements and workplaces significantly contribute to enhancing urban resilience. Karabakan & Mert (2021) emphasise the pivotal role of implementing green infrastructure systems in providing a certain degree of resilience. Furthermore, as stated by earlier scholars, land use is critical in determining urban efficiency, potential sustainability and resilience (Burby, Deyle, Godschalk, & Olshansky, 2000; Lu et al., 2020). These findings further strengthen the statement by Ewindy *et al.* (2021) regarding the implementation of strict land use as a means of disaster mitigation.

The thematic analysis reveals that spatial structure of a city, such as the presence of multiple service centre systems in Banda Aceh, had a positive influence on reinforcing the service system in the event of a disaster. This finding aligns with the assertion made by Feliciotti (2018) that polycentric city model may promote urban resilience by enhancing the modularity of infrastructure, functions and institutions of different sizes. This organisational framework effectively spreads risk across sub-centers and diversifies traffic flow, mitigating significant losses in areas with a high concentration of resources during a catastrophe.

This study reveals the prominence of spatial culture within the Islamic society of Banda Aceh, particularly in how people use space to accommodate their daily activities, such as the use and attachment to places of worship like mosques. This cultural expression significantly influences urban space and its resilience in the face of disasters. Consequently, the spaces shaped by the cultural practices of the Islamic community, reflecting local characteristics emerge as determining factors in spatial planning for urban resilience. This finding supports the results of previous studies (Jamalinezhad, Talakesh, & Soltani, 2012; Tabibian & Rezapour, 2016; Zuraidi, Caisarina, & Fuady, 2020) which consider that many cultural and site-specific parameters can hinder broad spectrum prescriptions. The findings also align with the conclusion of Karabakan & Mert (2021), stating that urban policies and spatial strategies should be tailored according to local characteristics and values, recognising the absence of a universal solution in this regard. Moreover, this finding resonates with the genius loci theory presented by Norberg-Schulz (2016), positing that the essence of place and the application that human life is included in local wisdom is called genius loci. This concept is also associated with a spiritual sense of place to contextually sustain and preserve the quality of life and local characteristics. The concept of genius loci has a significant role in enhancing urban resilience (Nur, 2020).

The study observes that non-physical factors related to space, including policies, actors/institutions, social, economic, evacuation systems and information, determine urban resilience. This observation also confirms previous research conducted by Amri & Giyarsih (2021), who emphasised the importance of strategies such as prohibiting occupancy in disaster-prone areas and establishing protected areas to mitigate risks. These strategies, when combined with policies related to building regulations, incentive mechanisms, determining evacuation routes, and other structural or non-structural measures, are crucial for enhancing resilience. Failure to formulate and implement appropriate policies can lead to undesirable consequences in the future.

Furthermore, this study finds that religious factors hold significant sway in spatial planning for enhancing urban resilience within Islamic societies. The thematic analysis identifies the influence of religious beliefs, practices and knowledge on spatial use in Banda Aceh City. This finding aligns with the theory put forward by Rüpke (2020), which posits that individuals use their faith as a resource for coping, recovering and growing. The findings also align with Gianisa and Le De's (2018) conclusions that religious beliefs and practices foster community cohesion and contribute to effective coping mechanisms during disasters. However, a lack of proper understanding of Islamic religious knowledge, especially among stakeholders in Banda Aceh, is considered as detrimental to the conditions of spatial planning, ultimately reducing urban resilience in this city. The importance of religious knowledge is also in line with Greed's perspective that there is a need to educate planners to reduce illiteracy and spiritual ignorance about the patterns, characteristics and values of religious group worship, all of which need to be integrated into the urban spatial planning process (Greed, 2016).

CONCLUSION

This paper aims to identify the determinants influencing spatial planning for urban resilience in an Islamic societal setting. It examines the literature gap by soliciting the perspectives of stakeholders in spatial planning and disaster management in Banda Aceh City, Indonesia. The results discovered determining factors specific to the Islamic society in Banda Aceh namely spatial pattern, spatial structure, spatial culture, spatial-related non-physical factors and religious factors. These results contribute to the advancement of knowledge in the field of urban planning related to spatial planning that accommodates the local socio-religious context, enhancing urban resilience to disasters based on Islamic values. Identifying the determining factors of spatial planning for urban resilience in the Islamic society context will provide essential insights into the need to increase urban resilience disaster-prone areas through informed urban planning, incorporating aspects of local wisdom and culture or societal needs. Given the context-specific nature of this research, future studies might explore comparative case studies in both developed or developing regions. A similar study conducted in a different city with shared characteristics, including susceptibility to multi-hazards and a predominantly Islamic population, would yield valuable comparative insights.

ACKNOWLEDGEMENTS

The authors are grateful for the funding support provided by Aceh Province Government, Indonesia under the Ph.D. Split- Site USK-UM Program.

REFERENCES

Aceh Province Disaster Management Agency. *Aceh Disaster Management Strategic Plan (2018-2022)*. , (2018).

Achmad, A., Burhan, I. M., Zuraidi, E., & Ramli, I. (2020). Determination of recharge areas to optimize the function of urban protected areas on a small island. *IOP Conference Series: Earth and Environmental Science*, *452*(1). https://doi.org/10.1088/1755-1315/452/1/012104

Burby, R. J., Deyle, R. E., Godschalk, D. R., & Olshansky, R. B. (2000). Creating Hazard Resilient Communities through Land-use Planning. *Natural Hazards Review*, *1*(2), 99–106.

Capello, R., Caragliu, A., & Fratesi, U. (2015). Spatial heterogeneity in the costs of the economic crisis in Europe. *Journal of Economic Geography*, *15*(5), 951–972.

Clarke, V., & Braun, V. (2017). Thematic analysis. *The Journal of Positive Psychology*, *9760*, 1–2. https://doi.org/10.1080/17439760.2016.1262613

Ewindy, J., Suganda, B. R., Asdak, C., & Sapari, M. (2021). Palu earthquake hazard risk assessment (EHRA) based on urban land use planning. *Acta Geologica Slovaca*, *13*(1), 79–84.

Feliciotti, A. (2018). *Resilience and urban design: a systems approach to the study of resilience in urban form*. University of Strathclyde.

Folke, C., Jansson, Å., Rockström, J., Olsson, P., Carpenter, S. R., Stuart Chapin, F., … Westley, F. (2011). Reconnecting to the biosphere. *Ambio*, *40*(7), 719–738. https://doi.org/10.1007/s13280-011-0184-y

Gianisa, A., & Le De, L. (2018). The role of religious beliefs and practices in disaster The case study of 2009 earthquake in Padang city, Indonesia. *Disaster Prevention and Management: An International Journal*, *27*(1), 74–86. https://doi.org/10.1108/DPM-10-2017-0238

Godschalk, D. R. (2003). Urban Hazard Mitigation: Creating Resilient Cities. *Natural Hazards Review*, *4*(3), 136–143. https://doi.org/10.1061/(asce)1527-6988(2003)4:3(136)

Government of The City Banda Aceh. *Banda Aceh City Qanun Number 2 of 2018 concerning Amendments to Banda Aceh City Qanun Number 4 of 2009 concerning Banda Aceh City Spatial Planning 2009-2029*. , (2018).

Greiving, S., & Fleischhauer, M. (2006). Spatial Planning Response towards Natural and Technological Hazards. *Geological SUrvey of Findland*, *Special Pa*(42), 109–123.

Hoa, N. T., & Vinh, N. Q. (2018). The notions of resilience in spatial planning for drought - flood coexistence (DFC) at regional scale. In Q. B. Bui, R. Cajka, M. T. Tran, T. A. Trinh, A. U. H. Yasar, G. Wets, & M. Woloszyn (Eds.), *2nd International Conference on Sustainable Development in Civil, Urban and Transportation*

Engineering (CUTE 2018) (Vol. 143). https://doi.org/10.1088/1755-1315/143/1/012066

Holling, C. S. (1973). Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics*, *4*, 1–23.

Jamalinezhad, M., Talakesh, S. M., & Soltani, S. H. K. (2012). Islamic Principles and Culture Applied to Improve Life Quality in Islamic Cities. *Procedia - Social and Behavioral Sciences*, *35*(December 2011), 330–334. https://doi.org/10.1016/j.sbspro.2012.02.095

Karabakan, B., & Mert, Y. (2021). Measuring the Green Infrastructure Resilience in Turkey. *Chinese Journal of Urban and Environmental Studies*, *9*(3). https://doi.org/10.1142/S2345748121500147

Lee, S., Kim, J., Maharani, Y., Paripurno, E., & Sunarno. (2017). Analysis of the Risk of Windstorm (angin puting beliung) in Indonesia. *Journal of the Wind Engineering Institute of Korea*, *Volume 21*, 21–28.

Lu, Y., Zhai, G., Zhou, S., & Shi, Y. (2020). Risk reduction through urban spatial resilience: A theoretical framework. *Human and Ecological Risk Assessment: An International Journal*, *27*(4), 921–937. https://doi.org/10.1080/10807039.2020.1788918

Malalgoda, C., Amaratunga, D., & Haigh, R. (2013). Creating a disaster resilient built environment in urban cities: The role of local governments in Sri Lanka. *International Journal of Disaster Resilience in the Built Environment*, *4*(1), 72–94. https://doi.org/10.1108/17595901311299017

Mazlan, N. A., Zainol, R., Adilah, Y., & Harumain, S. (2022). Resiliency of Urban Informal Economic Activities in Kuching City. *Planning Malaysia: Journal of the Malaysian Institute of Planners*, *20*(5), 248–259.

Meerow, S., Newell, J. P., & Stults, M. (2016). Defining urban resilience: A review. *Landscape and Urban Planning*, *147*, 38–49. https://doi.org/10.1016/j.landurbplan.2015.11.011

Nur, K. W. (2020). Alley activation: Genius loci to construct a resilient city. *Journal of Architecture and Urbanism*, *44*(1), 63–68. https://doi.org/10.3846/jau.2020.11015

Panagopoulos, T., Jankovska, I., & Bostenaru Dan, M. (2018). Urban green infrastructure: The role of urban agriculture in city resilience. *Urbanism. Architecture. Constructions*, *9*(1), 55–70.

Pickett, S. T. A., Cadenasso, M. L., & Grove, J. M. (2004). Resilient cities: Meaning, models, and metaphor for integrating the ecological, socio-economic, and planning realms. *Landscape and Urban Planning*, *69*(4), 369–384. https://doi.org/10.1016/j.landurbplan.2003.10.035

Pokhrel, S. (2019). Green space suitability evaluation for urban resilience: an analysis of Kathmandu Metropolitan city, Nepal. *Environmental Research Communications*, *1*(10). https://doi.org/10.1088/2515-7620/ab4565

Pozoukidou, G. (2020). Designing a green infrastructure network for metropolitan areas: a spatial planning approach. *Euro-Mediterranean Journal for Environmental Integration*, *5*(2). https://doi.org/10.1007/s41207-020-00178-8

Rogatka, K., Starczewski, T., & Kowalski, M. (2021). Urban resilience in spatial planning of polish cities - True or false? Transformational perspective. *Land Use Policy*, *101*. https://doi.org/10.1016/j.landusepol.2020.105172

Rüpke, J. (2020). 7. Urban resilience and religion: Attaching time to place. In *Urban Religion* (Vol. 67). https://doi.org/10.1515/9783110634426-009

Sagar, K. (2017). Integrating disaster risk reduction and urban planning: Evidence from class III City-Rajgir, India. *International Journal Of Advance Research And Innovative Ideas In Education*, *3*(1), 237–252.

Sulaiman, N., She, T. W., & Fernando, T. (2019). Community resilience frameworks for building disaster resilient community in Malaysia. *Planning Malaysia: Journal of the Malaysian Institute of Planners*, *17*(1), 94–103. https://doi.org/https://doi.org/10.21837/pm.v17i9.589

Tabibian, M., & Rezapour, M. (2016). Assessment of urban resilience: a case study of Region 8 of Tehran city, Iran. *Scientia Iranica*, *23*(4), 1699–1707. https://doi.org/10.24200/sci.2016.2240

UNDRR. (2015). Sendai Framework for Disaster Risk Reduction 2015-2030. In *United Nations for Disaster Risk Reduction* (Vol. 144). Sendai.

Wamsler, C. (2014). *Cities , Disaster Risk* (M. Miles, Ed.). London and New York: Routledge, Taylor and Francis.

Wegener, M. (1998). GIS and spatial planning. *Environment and Planning B: Planning and Design*, (Anniversary Issue), 48–52.

Yoshida, T., Yamagata, Y., Chang, S., Jittrapirom, P., & Voulgaris, G. (2020). Spatial modeling and design of smart communities. In *Urban Systems Design*. https://doi.org/10.1016/B978-0-12-816055-8.00007-5

Zuraidi, E., Caisarina, I., & Fuady, Z. (2020). The Islamic public space concept in the Southeast Asia region as a friendly urban design and planning enlightening. *IOP Conference Series: Earth and Environmental Science*, *452*(1). https://doi.org/10.1088/1755-1315/452/1/012146

Zuraidi, E., Zainol, R. B., Ahmad, Y. Bin, & Achmad, A. (2022). Understanding the evolution and global trends of resilience and urban planning studies: A bibliometric analysis. *Planning Malaysia: Journal of the Malaysian Institute of Planners*, *20*(5), 260–271. https://doi.org/https://doi.org/10.21837/pm.v20i24.1203

Received: 7th June 2023. Accepted: 5th September 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 237 – 252

SPATIAL WALKABILITY INDEX (SWI) OF PEDESTRIAN ACCESS TO RAIL TRANSIT STATION IN KUALA LUMPUR CITY CENTER

Nurfadhilah Ruslan [1], Nabilah Naharudin [1], Abdul Hakim Salleh[3], Maisarah Abdul Halim[1, 4], Zulkiflee Abd Latif[1]

[1]*School of Geomatics Science and Natural Resources,*
College of Built Environment,
UNIVERSITI TEKNOLOGI MARA
[3]*School of Engineering, Engineering Campus,*
UNIVERSITI SAINS MALAYSIA
[4]*Center for Sustainable Urban Planning & Real Estate (SUPRE),*
Faculty of Built Environment,
UNIVERSITI MALAYA

Abstract

Walkability is crucial for sustainable transportation in cities but measuring it may be difficult due to unclear criteria that could be used as well as the methods available. This study aims to measure the Spatial Walkability Index (SWI) of pedestrian access to rail transit stations in Kuala Lumpur City Center by using a comprehensive set of criteria including Connectivity, Land use mix, Comfort, Security, and Safety, which are all represented as ground measurable parameters in this study. SWI was derived using Analytical Network Process (ANP) and GIS analysis. ANP is a decision-making technique that uses pairwise comparison to derive the weightage of the ground measurable parameters which then were used to determine the SWI for pedestrians by using GIS proximity analysis. In this analysis, the weightage of parameters located on the road were used as basis in deriving the SWI. As a result, the SWI for pedestrian access to rail-transit stations in KL City Center was determined. The results revealed that the SWI for most of the area was in average level. Based on analysis conducted, the SWI was greatly influenced by its criteria, proving how ANP can aid in analyzing the SWI by incorporating the weightage of its criteria.

Keywords: ANP, GIS, MCDA, rail transit, walkability

[1] Corresponding author Email: nabilahnaharudin1290@uitm.edu.my

INTRODUCTION

Walkability is one of the keys in enhancing the sustainable transportation in a city. A walkable environment in a city could help in the reduction of reliance on private motor vehicles by encouraging more people to use active or public transportation instead. Walkability supports the concept of sustainable transportation, where it finds a proper balance between (current and future) environmental, social, and economic qualities (Litman, 2003; WCED, 1987). This concept is crucial in achieving sustainable transportation in the future due to its relation to supply, demand, and resource management (Rosalin et al., 2019). The concepts that imply the effect of economic, social, and environmental factors are Sustainable Development Goals (SDGs) and Transit Oriented Development (TOD).

SDGs are a global agenda for sustainable cities and communities to help transform our world toward a better sustainable future for people, the planet, prosperity, peace, and partnership. The SDGs set universal goals that balance the three dimensions of sustainable development, which are social, environmental, and economic (Department of Statistics Malaysia (DOSM), 2000). Malaysia is currently focusing on the development of the public transport infrastructure as the government sees the importance of public transportation to the urban community, especially the Rail Transit Service.

Besides, the TOD concept aims to help improve the economy and quality of life to manage a more comfortable and organized way according to their respective capabilities (Rahmat et al., 2016). The basic elements of TOD are designed for compact land use mix, creating a high-quality pedestrian-oriented environment and place at easily accessible locations. These elements must be included in a radius of 400 meters from the transit station. In Malaysia, the concept of TOD has been implemented by the Public Land Transport Agency (APAD) to plan public transport by applying the concepts of Mix, Densify, Compact, Shift, Walk, Cycle, Connect, and Transit.

Hence, the measurement of the walkability of pedestrian access to rail transit stations is required to support the concept of SDGs and TOD for sustainable transportation within the Kuala Lumpur City Center. Walkability is determined by calculating the walkability index. The walkability index is used to assess the walkability of the environment (Naharudin et al., 2020). In this study, the walkability index measurement was obtained using mixed methods, namely the Analytical Network Process (ANP) and Geographical Information System (GIS). The mixed methods translate the human perceptions of their feelings and experiences using the pedestrian access and spatially interpret them in the GIS environment. Therefore, this study was conducted to evaluate pedestrian access to rail transit stations in order to implement sustainable transportation in the Kuala Lumpur City Center.

LITERATURE REVIEW

Concept of Walkability

Walkability is related to how friendly an area of pedestrian networks is to the user (Lo, 2009; Abley et al., 2011; Ozbil et al., 2015; Frilund, 2017; Razali et al., 2017; Naharudin et al., 2017; Khalaf & Ja'afar, 2020; Jian et al., 2020; Wan Mohammad et al., 2021; Tobin et al., 2022). It may be influenced by the built environment in the walking area, such as amenities and facilities (Ariffin & Zahari, 2013; Lu, 2017; Ramakreshnan et al., 2020; Fonseca et al., 2022). A well-built environment should encourage more people to walk, and it should include the elements of safety and comfort. This is supported by the concept of Crime Prevention through Environmental Design (CPTED). The concept focuses on developing a good walking area to aid in crime prevention, thus encouraging more people to walk instead of relying on car or other private motor vehicles.

In addition to safety and comfort, walkability also focuses on convenience in terms of travelling time and distance. A reasonable walking distance of 30 minutes or less is a good practice for providing a walkable area (Both et al., 2022). Furthermore, walkability also focuses on having connectivity and accessibility of pedestrian network to various land use mixes, such as high density of neighborhood to the rail transit station and services area as this could also encourage different walking activities as people may travel for different purposes (Cervero, 2002; Hamid et al., 2015; Padon & Lamtrakul, 2019; Yun et al., 2020). Therefore, walkability could help in reducing the use of private vehicles and increase the ability to access the various mixed areas by foot as well as reduce our carbon footprint.

Walkability Criteria

Before measuring the walkability index, it is crucial to define the criteria and parameters. The criteria to measure the walkability index can be defined as the quantitative variables that are useful for demonstrating a complex phenomenon (EEA, 2005). However, it is challenging to select a set of criteria that provides comprehensive coverage of the reflected issue (Castillo & Pitfield, 2010). In this walkability index study, the criteria selection must be related to the definition of walkability, quantifiable, and understandable by users. The required data must be available easily at a reasonable cost (Li et al., 2009; Yigitcanlar & Dur, 2010; Zito & Salvo, 2011; Haghshenas & Vaziri, 2012).

To measure the walkability of pedestrian access to rail transit stations, it is essential to identify the appropriate criteria. In this study, the selection of criteria was based on a comprehensive review of previous studies and government policies. A thorough analysis of 52 previous studies was conducted to identify commonly used criteria. Additionally, a review of relevant government policies such as the Kuala Lumpur Structure Plan 2040, National Transport Policy 2019-2030, National Land Public Transport Master Plan, and

Putrajaya Structure Plan 2025 was conducted to align with Malaysia's planning and strategies for walkability issues.

Figure 1 summarizes the frequency of criteria employed in walkability studies. Based on the review, Security and Safety are the most commonly adopted criteria, appearing in 32 out of the 52 studies analysed. Close behind is Connectivity, utilized in 27 out of the 52 studies. Comfort on the other hand were employed in 21 out of 52 studies, indicating their significance in the research. Lastly, the criteria of Landuse Mix, appearing in only 15 out of the 52 studies.

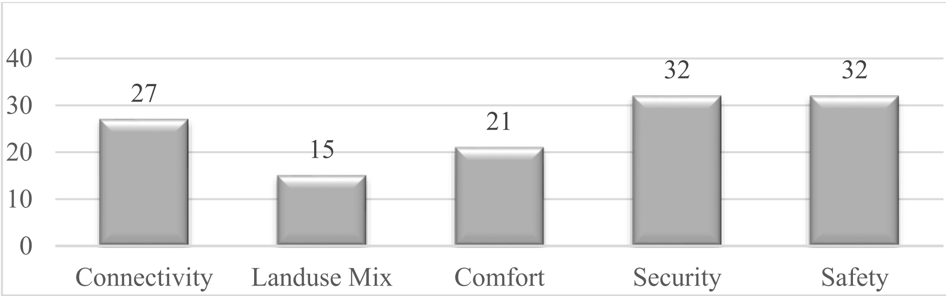


Figure 1: Summary of Criteria used in previous studies

MCDA

Multi-criteria decision analysis (MCDA) is a process of evaluating alternatives based on multiple criteria. Multi-attribute decision-making is used when the problem is to evaluate a finite set of alternatives and select the best one based on a set of attribute scores. Traditionally, multi-criteria decision-analysis techniques assume spatial homogeneity within a study area, although the criteria often vary across space in many decision-making problems (Tkach & Simonovic, 1997; Malczewski & Rinner, 2015).

MCDA is conducted using several techniques, namely Ranking, Rating, and Pairwise Comparison. Ranking techniques involve assigning priorities to criteria based on the decision maker's preferences (Malczewski & Rinner, 2015). Rating techniques involve assigning weights to criteria using a predetermined scale (Malczewski & Rinner, 2015). However, the effectiveness of these two techniques is limited by the number of criteria that need to be ranked or rated.

Pairwise comparison is a useful decision-making method, particularly in situations where multiple criteria are present to be considered. This technique allows decision-makers to determine the relative importance of each criterion and identify the most critical factors in the decision-making process. By comparing each criterion with every other criterion, pairwise comparison can help decision-makers create a hierarchy of criteria based on their relative importance. The Analytical Hierarchy Process (AHP) and Analytical Network Process (ANP) is another popular method that uses pairwise comparison to prioritize criteria in decision-making**.** The ANP pairwise comparison determines the importance of the criteria based on scale judgments from 1 to 9, with 1 representing the least important and 9 representing the most important.

ANP structures the MCDA into a network. Meanwhile, the AHP structures the decision problem into a hierarchy. Pairwise comparison is adopted into the ANP method where it is most appropriate since it allows interdependencies between the criteria despite the hierarchy (AHP), which is suitable for the walkability criteria that can influence each other (Saaty & Vargas, 2006). AHP is useful for simple decision-making problems with a limited number of criteria and alternatives, and ANP is more appropriate for complex decision-making problems with redundancies and feedback among criteria.

GIS in Measuring Walkability

The combination of GIS and MCDA approach is an efficient method for walkability analysis as it is capable of dealing with various factors that would potentially impact walkability (Nasef, 2021). The study by Naharudin et al. (2017) adopted the GIS-MCDA to measure the walkability to and from LRT stations in Kuala Lumpur City Center. A study by Nasef (2021) also used GIS-MCDA for walkability assessment between two counties in Sweden. Azlan and Naharudin (2020) used GIS-MCDA to measure the safety index for pedestrian paths. The combination of MCDA with GIS allows the integration of the ground data and human perception data collected via surveys or questionnaires as the attributes for better analysis and understanding of walkability. GIS is powerful in storing, editing, and manipulating spatial data for better analysis and visualization. GIS allows the ground data, such as facilities along the walking area, to be represented spatially in GIS software.

RESEARCH METHODOLOGY

Figure 2 shows the methodology flowchart used in this study. The study was conducted in five (5) stages.

The first stage involves criteria selection based on a literature review, which aims to analyze previous studies that measured the walkability index. As no universal criteria exist for measuring the SWI worldwide, this study combines human perception with spatial data to accurately measure the walkability index. In this study, the criteria selected are 1) Connectivity, 2) Land use mix, 3) Comfort, 4) Security, and 5) Safety. Seventeen (17) measurable ground parameters represent each criterion to calculate the SWI and present it spatially in the GIS environment.

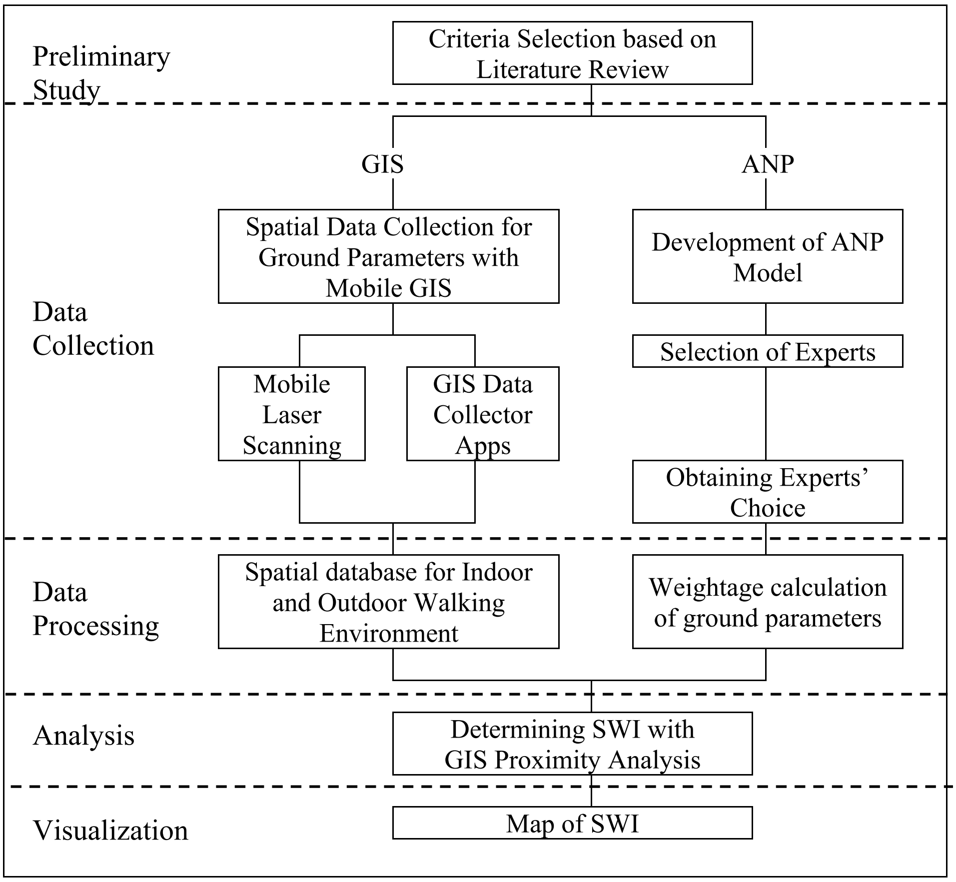


Figure 2: Methodology Flowchart

The GIS method uses mobile GIS to collect spatial data representing the ground parameters. The spatial data is divided into two, namely indoor and outdoor spatial data. A handheld mobile laser scanning was used for indoor data collection, and a smartphone GIS data collector was used for outdoor data collection. The spatial data collected was then imported into the GIS software. The data was then cleaned and edited to ensure the spatial data was ready for use in data analysis.

The ANP method involves several approaches that are developed from the ANP model to illustrate the relationships between the goals, criteria, and sub-criteria/elements. Then, the selection of experts was derived from ten experts who are familiar with the subject matter. The experts' ratings were obtained by the ANP survey, which was developed based on pairwise comparison techniques. Finally, the weightage for criteria and ground parameters was calculated based on Equation 1.

$$Aggregated\ priorities,\ W_k = \frac{\sum_{p=1}^{n} C^{*}_{kp}}{n}\ for\ all\ k = 1,2 \dots n, \quad (1)$$

As mentioned previously, this study involved several experts. Thus, a group judgment needs to be derived using a geometric mean based on Equation 2.

$$Geometric\ mean = \sqrt[xn]{x1\,.\,x2\,.\,x3\,\dots.\,xn} \quad (2)$$

$$where\ x1, x2, x3 \dots..xn\ is\ the\ number\ of\ expert\ judgements$$

Then, the weightage for ground parameters was joined with the spatial data collected as their attributes. Then, near analysis, which is a part of proximity analysis, was used to obtain how many ground features were located within one road. Then, the total weightage of every route was calculated by using Equation 3.

SWI = (CON+MIX+CFT+SEC+SAT) X 100 (3)

Where;

SWI = Spatial Walkability Index
CON = Street Connectivity
MIX = Land Use Mix
CFT= Comfort
SEC= Security
SAT = Safety

ANALYSIS AND DISCUSSION

Weightage of Criteria and their Ground Parameter

The weightage for each criteria and their ground parameters were calculated based on the experts' choice given by selected group of experts from academicians and industrial experts, as summarized in Table 1. They were selected due to their experiences in studying and working on walkability issues. This study chose to have a balance number of academician and industrial experts to have a balance perspective from both sides. The experts' choices were obtained by using a pairwise comparison method as explained in previous section.

Table 1: Expert Judgements Descriptions

Experts		**Descriptions**
Academician	A1	Professor from local university
	A2	Professor from local university
	A3	Professor from local authority
	A4	Graduate student from local university
	A5	Graduate student from local university
Industrial Experts	I1	Local Authority
	I2	Local government from town planners
	I3	Local government from transport planners
	I4	Consultant
	I5	Consultant

The highest weightage value obtained was Security criteria, with a value of 0.245. Next, the highest weightage was Safety criteria, with a value of 0.224, followed by Connectivity criteria, with a value of 0.170. Meanwhile, the lowest weightage value was obtained for Land use criteria, with a value of 0.143.

Table 2: Final Weightage from group judgements

Criteria/Ground Parameter	**Group Judgements**
CONNECTIVITY	0.170
Intersection	0.095
Cul de sec	0.065
Dead End	0.060
LAND USE MIX	0.143
Residential Area	0.027
Job Area	0.023
Educational area	0.029
Industrial area	0.018
Existing Rail Transit Station	0.032
COMFORT	0.166
Benches	0.023
Signage	0.056
Information counter	0.030
Row of tree	0.062
SECURITY	0.245
Pedestrian Bridge	0.096
Pedestrian Subway	0.061
Street Light	0.109
SAFETY	0.224
Crossing Safety	0.063
Traffic Light	0.068

The rank of priorities for each criterion is similar to previous studies as shown in Figure 1, but there are also differences which may be due to how the criteria was interpreted in other studies that may not be similar with this study. For example, there are studies used Safety and Security interchangeably as they are quite similar. However, looking at the weightage of both, they are still the most important criteria in walkability as no matter what, pedestrian safety and security must always be prioritized the most.

The weightage derived for each ground parameters reflect how ANP works in deriving weightage for criteria and their subcriteria in a decision-making analysis. As mentioned earlier, experts have identified Security as the most important criterion for measuring the SWI. Thus, as in ANP, the weightage of subcriteria was influenced by weightage of main criteria, both Street Lights and Pedestrian Bridges weighed as the most important too. Similarly, the ground parameters for Landuse Mix, Existing Transit Stations, Educational Areas, Residential Areas, Job Areas, and Industrial Areas all have the lowest weightages among other ground parameters as they are influenced by the weightage of their main criteria (Landuse Mix) which is the lowest among all, thus they also received low weightages.

SWI of Pedestrian Access to Rail Transit Station

The calculated SWI were classified into five (5) classes by using Jenks method as shown in Table 3. The Classes of A to E, represent a distinct level of walkability where Class A indicates very high walkability; Class B is a high walkable area; Class C is moderate; Class D is low walkability; and Class E is very low walkability.

Table 3: SWI Classes

SWI	Class	Walkable
0.000 – 1.808	E	Very Low
1.809-5.915	D	Low
5.916– 13.137	C	Moderate
13.138 – 28.272	B	High
28.273 – 100.000	A	Very High

Based on Figure 2, most primary roads are classified as Class E with values 0 to 1.808. The primary roads, which connect the basic network within the state and link state capitals and towns, are the main access to private vehicles and public transport in Kuala Lumpur city center. The development of expressways and Federal roads, such as Lebuhraya Sultan Iskandar, Jalan Tun Razak, Jalan Damansara, and Jalan Istana, connecting the sub-urban with Kuala Lumpur City Center, has also increased the dependency on private vehicles. This is likely due to the limited connection of pedestrian networks with primary roads, making pedestrian destinations unfeasible within walking distance.

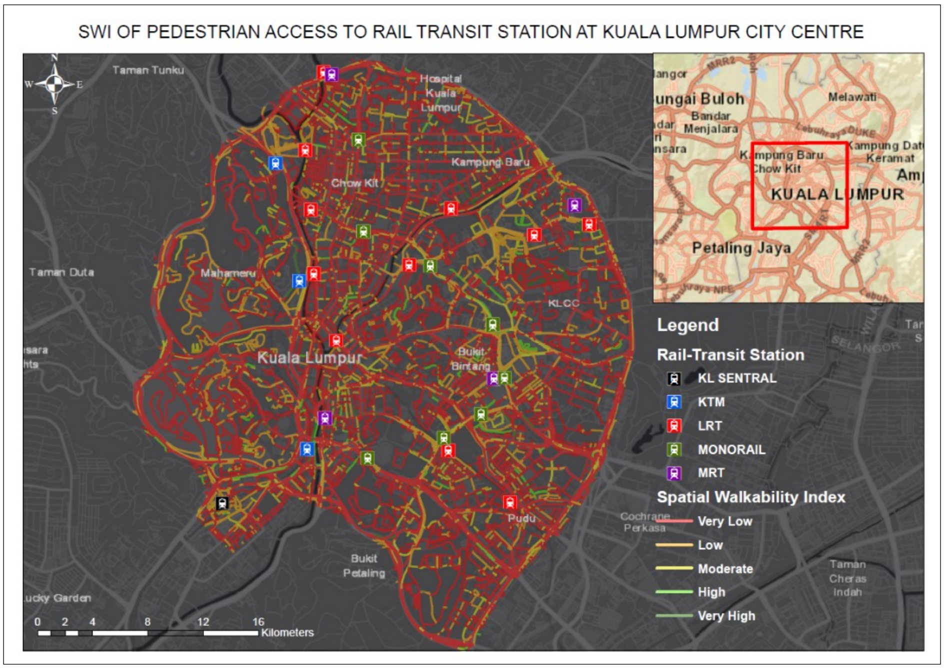


Figure 3: SWI of pedestrian access to rail transit station in KL City Center

However, in the crowded areas within the city, such as Bukit Bintang, KLCC, and Chow Kit, the resulting SWI was Class C, with values ranging from 5.916 to 13.137. These areas are known as the center of Kuala Lumpur, surrounded by various land use mixes, such as entertainment areas, commercial areas, working areas, and transit station areas. Additionally, these areas are attractive to local people and tourists due to exclusive shopping malls like Pavillion, Lalaport, Suria KLCC, Time Square, and SOGO. The well-built environment in these areas focuses on pedestrians, with facilities such as streetlights, pedestrian walkways, benches, and good signage, which contribute to walking activities. Moreover, the attractive areas are located within walking distance, eliminating the need for private vehicles.

The existing rail transit station is considered important for measuring the SWI. Among the four types of land use mixes, the weightage value for the existing rail transit station was higher, indicating its greater importance. The experts judged that access to rail transit stations are more important than access to residential, job, educational, and industrial areas. Rail transit is an essential public transport option in Kuala Lumpur City Center, comprising Light Rapid

Transit (LRT), Mass Rapid Transit (MRT), and monorail systems. This study obtained the SWI along the pedestrian access to a rail transit station in Classes A to C, as shown in Figure 4.

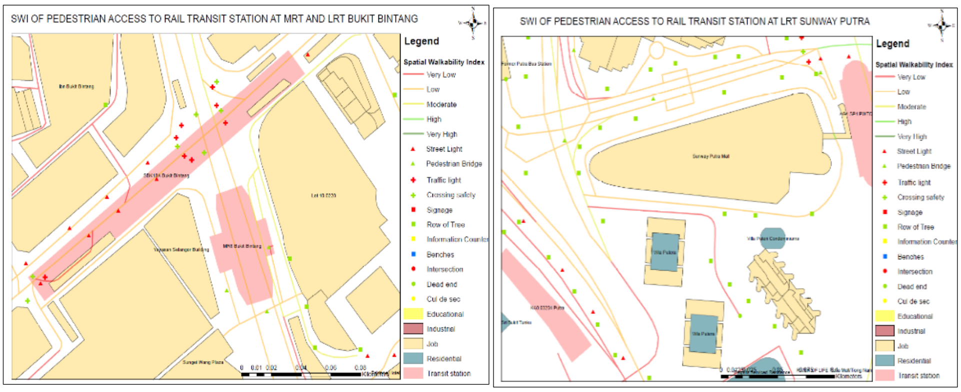


Figure 4: SWI of pedestrian access at MRT and LRT Bukit Bintang and Sunway Putra Mall varied from Class A to Class C

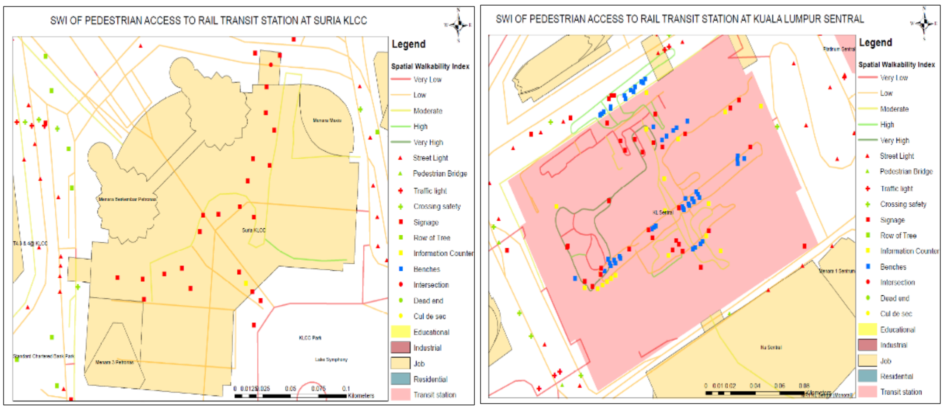


Figure 5: SWI of pedestrian access at indoor buildings, Suria KLCC and KL Sentral

In this study, the measurement of SWI is not limited to the outdoor environment but also includes the indoor building. Pedestrians tend to enter indoor buildings rather than walk around them as it reduces both distance and travel time. The buildings in Kuala Lumpur City Center, such as shopping malls and transit stations, were built to connect to outdoor pedestrian walkways to provide comfort and convenience to pedestrians and public transport users. Pedestrians can find various walking directions inside a building, which may not be possible with physical pedestrian access. Additionally, it protects them from the rain and hot sun. Figure 5 illustrates the SWI of pedestrian access in Suria

KLCC and Kuala Lumpur Station Center. The figure shows that ground parameters in indoor buildings, such as benches, signage, and information counters, have an average weightage value as assessed by the experts. Thus, the SWI of pedestrian access in these buildings falls between Classes B and C. These ground parameters help pedestrians navigate the buildings and reach their destinations.

SWI of Existing Rail Transit Station

The SWI for existing rail transit stations was determined through proximity analysis, which calculated the highest SWI of pedestrian access within a 400m buffer around the station. This was based on the TOD concept, which located transit stations within 400m walking distance in mixed land use areas. The intersection analysis was used to extract the SWI values for pedestrian access within 400m of each existing rail transit station. Table 2 summarizes the SWI values for each station, with KTM Bank Negara having the highest SWI of 99.507, followed by MRT Bukit Bintang with 99.489. These SWI values indicate that all the rail transit stations were properly planned and developed according to the TOD concept. While some stations have lower SWI values due to a lack of ground parameters, they still meet the TOD concept requirements as they are located within various land use mixes and at easily accessible locations.

Table 4: SWI of existing rail transit within selected rail transit station in Kuala Lumpur City Center

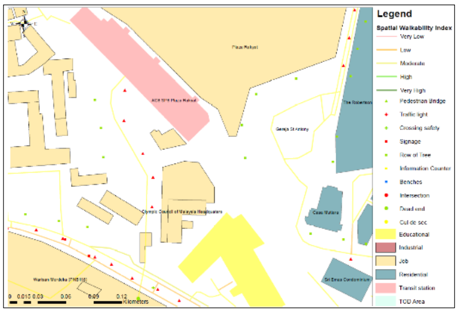
LRT/MRT Station	SWI of Existing Rail Transit
KL Sentral	99.116
LRT Hang Tuah	99.036
MRT Bukit Bintang	99.489
LRT Bukit Nanas	98.519
Ampang park	99.204
LRT PWTC	98.432
KTM bank negara	99.507
LRT KLCC	99.301
LRT Pudu	99.314

The location of KTM Bank Negara provides good connectivity between the nearby office work areas, Bank Negara, and the entertainment areas, namely SOGO, Jalan Tar, and Masjid India. These locations are aligned with the TOD concept, which requires rail transit stations to be situated in easily walkable areas with diverse land use mixes. The high SWI value of pedestrian access at LRT Bank Negara confirms its contribution to the SWI of existing rail transit stations. Additionally, the implementation of ANP techniques also contribute to the value of criteria used to measure the SWI.

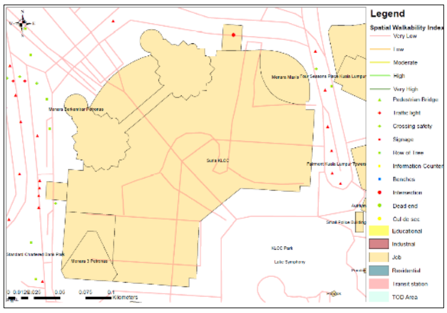
METHODS' SENSITIVITY TEST FOR MEASURING SWI

To validate the methodology used for SWI measurement, a virtual Street Lights parameter was added in the analysis. This addition aimed to analyse enhance the accuracy and reliability of the methods. As a result, the SWI for the specific route was re-computed, and the classification was updated to Class C, as depicted in Figure 6(a).

Furthermore, the methods was validated by analysing the inclusion of indoor walking environment in the walkability assessment. This was necessary because this study highlighted the importance of including the indoor walking environment in walkability assessment when many other studies did not do so as discussed previously. Consequently, in this study, the indoor walking environment had contributed significantly to the highest SWI of the existing rail transit station. To evaluate the impact of the indoor walking environment, the data pertaining to indoor walking environment connecting the KLCC LRT station with Suria KLCC, was removed, and the SWI was recomputed. Upon re-computation, the SWI for the indoor area of Suria KLCC resulted in classifications ranging from class C to E (previously A to C) as illustrated in Figure 6(b). This validated the needs on including indoor walking environment in enhancing the walkability assessment.



(a)



(b)

Figure 6: SWI Sensitivity Testing when Virtual Streetlights was added (a) and Indoor Environment removed (b)

In conclusion, the methods utilized in this study to compute the SWI underwent validation to assess its accuracy. The results demonstrated that the SWI were influenced by the inclusion or exclusion of various ground parameters within the analysis. This indicates that the framework is capable of capturing and reflecting the impact of different factors on walkability. Thus, the methods can be considered reliable and suitable for further analysis and research pertaining to walkability assessments.

CONCLUSION

This study aims to measure the walkability index of pedestrian access to rail transit stations. This study began by defining a set of criteria for measuring walkability through an inclusive review of literature and national policies. The validity of these criteria was further supported by verification from experts, including academics and urban planners. Furthermore, this study employed the ANP technique to determine the degree of importance for the walkability criteria. By utilizing pairwise comparison methods, the degree of importance for each of the criteria and their ground parameters were obtained. The preferences expressed by the experts were helpful in determining the final weightage, based on their experience with walkability issues. Then, by using the weightage, the SWI for pedestrian access to rail transit stations were determined by using GIS analysis. The computation within a GIS environment allows for better analysis and interpretation of the SWI, particularly through the visualization and mapping of results.

This study introduced novelty in measuring the walkability in Malaysia. It incorporated existing studies and national policies to establish criteria for measuring walkability. It also introduced the integration of indoor walking environments, making the SWI more realistic based on real-world situations. In conclusion, the study's walkability framework, despite low SWI in Kuala Lumpur City Centre, shows potential by including various criteria and indoor walking environments. This enhances walkability assessment compared to not including these factors.

ACKNOWLEDGEMENT

This study was supported and funded by the Ministry of Higher Education (MOHE) under FRGS-RACER grant: 600-IRMI/FRGS-RACER 5/3 (013/2019).

REFERENCES

Abley, S., Turner, S. & Singh, R. (2011). Predicting Walkability. *Transportation Group Conference. March, 2011.*

Ariffin, R.N, R & Zahari, R.K. (2013). Perceptions of the urban walking environments. *Asia pacific international conference on environment-behaviour studied.*

Both, A., Gunn, L., Higgs, C., Davern, M. (2022). Achieving 'Active' 30 minutes cities: How feasible is it to reach work within 30 minutes using active transport modes? *Special Issues geo-information applications in active mobility and health in cities.*

Castillo, H. and Pitfield, D. (2010). ELASTIC – a methodological framework for identifying and selecting sustainable transport indicators. *Transportation Research Part D, Vol. 15, No. 4, pp.179–188.*

Cervero, 2002. Built environments and mode choice: toward a normative framework. *Transportation Research Part D 7 (2002) 265-284*

EEA. (2005). EEA core set of indicators: Guide. Retrieved from Copenhagen

Fonseca, F., Fernandes, E. & Ramos, R. (2022). Walkable Cities: using the smart pedestrian net method for evaluating a pedestrian network in Guimaraes, Portugal. *Journal sustainability Vol. 14, Issue 16*

Hamid, A.N., Hasmi, M., Tan, P.L., Mustafa, M. & Rohana, S. (2015). Towards Predicting the walkability of pedestrian rail commuters in Kuala Lumpur Conurbation. *International Journal of Humanities, Arts and Social Sciences*

Haghshenas, H. & Vaziri, M. (2012). Urban sustainable transportation indicators for global comparison. *Volume 15, Issue 1.*

Jabatan Perangkaan Malaysia (2018). Data for SDG reporting. *Konvensyen Permekasaan Pihak Berkuasa Tempatan.*

Jian, I.Y., Chan, E.H.W., Luo, M, J., Yao, T.Y., Wang, Q.C. (2020). A spatial justice study of pedestrian-friendly routes to privately owned public open space in Hong Kong. *Semantics Scholar*.

Khalaf, O.A. & Ja'afar, N, H. (2020). User-friendly streets for a walkable, liveable and sustainable environment: A review. *Jurnal Kejuruteraan 32(2). 2020: 53-58*

Li, F., Harmer, P., Cardinal, B. & Vongjaturapat, N. (2009). Built environment and changes in blood pressure in middle aged and older adults. *Volume 48, Issues 3*

Litman, T. & Burwell, D. (2006). Issues in Sustainable Transportation. *International Journal Global Environmental issues, Vol. 6, No. 4.*

Malczewski, J. & Rinner, C. (2015). Multicriteria decision analysis in geographic information science. *Advance in Geographical Information Science Book. Publisher, Springer, 2015*

Naharudin., N., Salleh,A.H., Halim, A. M. and Latif, A.Z. (2020). Conceptual framework for walkability assessment for pedestrian access to rail transit services by using spatial-MCDA. *IOP conference series: earth and environmental science 540 (2020) 012023.*

Naharudin., N., Ahmad, S.M.S and Sadullah, M.F. (2017). Framework for developing a spatial walkability index (SWI) for the light-rail transit (LRT) stations in Kuala Lumpur city centre using analytical network process (ANP) and GIS. *Proceedings of the international conference of global network for innovative technology and AWAM international conference in civil engineering*.

Naharudin., N., Ahmad, S.M.S and Sadullah, M.F. (2017). Optimizing Pedestrian-Friendly Walking Path for the First and Last Mile Transit Journey by using the Analytical Network Process (ANP) Decision model and GIS Network Analysis. *Volume XLII-4/W5, 2017*

Nasef, O. (2021). Walkability assessment using GIS-MCDA: A case study of two counties Gavle and Uppsala in Sweden. *Master Dissertation, University of Gavle.*

Ozbil, A., Yesiltepe, D. & Argin, G. (2015). Modelling walkability: The effects of Street Design, street-network configuration and land-use on pedestrian movement. *Journal of the Faculty of Architecture*.

Padon, A. & Iamtrakul, P. (2021). Land use and transport integration to promote accessibility in the proximity of mass transit station. *Faculty of architecture and planning, centre of excellence in urban mobility research and innovation*.

Rahmat, A., Endot, I.R., Ahmad, Z., Ishal, Z. & Ibrahim, C.K.I (2016). Development of Transit Oriented Development (TOD) model for Malaysia. *Journal of Built Environment, Technology and Engineering, Vol. 1(Sept.)*

Ramakreshnan, L., Fong, C.S., Sulaiman, N.M. & Aghamohammadi, N. (2020). Motivation and built environment factors associated with campus walkability in the tropical settings. *Science of The Total Environment Volume 749, 20 December 2020, 141457*

Razali, H.R., Tobi, S.U.M., Bilyamin, S.F.I. & Wahab, M.H. (2017). The influence of walkability towards urban street design in Kuala Lumpur. *UTM Razak School Engineering and Advance Technology.*

Rosalin, A., Kombaitan, B., Zulkaidi,D., Dirgahayani, P. & Syabri, I. (2019). Towards Sustainable Transportation: Identification of Development Challenges of TOD area in Jakarta Metropolitan Area Urban Railway Projects. *The 4rd International Conference in Planning in the 2019 Era of Uncertainty*

Saaty, T.L. (1980). The Analytic Hierarchy Process, *McGraw-Hill, New York*

Yun, S.C.J., Hoe, G.B., Yenn, T.F., Gyoo, K.B. and Wah, Y.C. (2020). Pedestrian walkability index for light rail transit (LRT) stations in Klang valley. *Proceedings of AICCE'19*

Tkach, R., J. & Simonovic, S.P. (1997). A new approach to Multi-criteria Decision Making in water resources. *Journal of Geographical information and decision analysis, Vol.1*

Tobin,M., Hajna, S., Orychock,K., Ross, N., DeVries, M. (2022). Rethinking walkability and developing a conceptual definition of active living environments to guide research and practice. *BMC Public Health Articles*

Wan Mohammad, W.S.N., Lokman, N.I.S., Hasan, R., Hassan, K., Ramlee, N., Nasir, M., Yeo, L.B & Abu Bakar, K.A. (2021). The implication of street network design for walkability: A review. *The 5th conference on rebuilding place.*

Yigitcanlar, T. & Dur, F. (2010). Developing a Sustainability Assessment Model: The Sustainable Infrastructure, Land-Use, Environment and Transport Model. *sustainability ISSN 2071-1050 www.mdpi.com/journal/sustainability*

Zito, P. & Salvo, G. (2011). Toward an urban transport sustainability index: a European comparison. *European Transport Research Review, 3, pp. 179–195, 2011*

Received: 24th July 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 253 – 266

INTEGRATING RAINWATER HARVESTING AND GREYWATER RECYCLING TO INCREASE WATER EFFICIENCY IN OFFICE BUILDINGS

Nurhazwani Habibullah[1], Syazwani Sahrir[2*], Zakiah Ponrahono[3]

[1,2,3] *Department of Environment,*
Faculty of Forestry and Environment,
UNIVERSITI PUTRA MALAYSIA

Abstract

Water is an essential component of existence. It is one of the primary resources for maintaining a daily presence. Due to high demand, freshwater becomes limited; therefore, rainwater harvesting and greywater recycling should be implemented as an alternative to substituting freshwater consumption for non-potable activities. This study discusses the implementation of rainwater harvesting and greywater recycling and the contribution to water efficiency and the environment. The main objectives of this paper are to explicate the potential benefits of integrating rainwater harvesting and greywater recycling in office buildings and to elucidate the impact of water conservation from office buildings on the environment. The result shows that implementing both systems in buildings can reduce freshwater consumption, water saving, and the discharge of wastewater to the environment, which is an essential point for water efficiency. The findings can serve as a reference for stakeholders, as they can reduce the freshwater consumption for non-potable activities and increase the water efficiency of buildings, thereby alleviating freshwater scarcity in the future.

Keywords: Rainwater Harvesting, Greywater Recycling, Potable Water, Non-Potable Water, Water Efficiency

[2] Lecturer at Universiti Putra Malaysia. Email: syazwani_sahrir@upm.edu.my

INTRODUCTION

Water is one of the precious elements on earth that is essential to human life. Consequently, the availability of clean water is decreasing, leading to its scarcity. The rapid development and population growth have led to an increasing demand for water consumption and increased water pollution levels in Malaysia. As a developing country Malaysia adopts green programmes (green buildings and green technologies), where the government implements them and focuses on the improvement of living standards, promoting a sustainable development system, preserving and conserving the environment and green supply management (Shaharudin et al., 2022). According to Chi et al. (2020), green buildings can be defined as buildings that go beyond conventional codes, have higher sustainability goals in energy saving, carbon emission reduction, and indoor air quality improvement besides emphasising the efficient use of water and materials, as well as reduced impacts on human health and the environment throughout the building's life cycle.

Water efficiency is one of the criteria of the green building concept that has been implemented in the building operation by conserving water consumption, substituting freshwater with rainwater harvesting and greywater for domestic use. With rainwater harvesting, water saving is from 12% to 100% depending on the amount of precipitation, water consumption per person, household economic self-sufficiency, roof type, number of occupants, and the life cycle of the technology that is used (Şahin & Manioğlu, 2019). Therefore, rainwater harvesting should be essential to augment urban and rural water supply (Al-Batsh et al., 2019). Meanwhile, greywater from lightly polluted yet more significant volume streams, such as hand-basins and laundry, requires significantly less treatment if they are separated from streams with high organic loads originating from the kitchen and toilet (Pradhan et al., 2019). Rainwater harvesting and greywater can be recycled to minimise freshwater consumption and increase efficiency.

As Malaysia is blessed with tropical rainforests, it is one of the countries that receives a high volume of monthly and yearly rainwater (Lani et al., 2018). Therefore, implementing rainwater harvesting is feasible for all types of structures, particularly office buildings. Besides, office buildings have a high occupancy rate during the daytime, when the generation level of greywater is at its peak, thus it is the perfect time to collect greywater from human activities from the use of wash basins and ablution water. This circumstance will lead to the effectiveness of using rainwater and greywater for domestic purposes due to the continuity of the sources.

LITERATURE REVIEW

Rainwater harvesting

Harvesting rainwater as an alternative source of raw water supply has been practised for centuries in various countries to cope with water shortages in the community (Murdiana et al., 2019). It can also be used as an alternative water source in conjunction with the conventional water supply in buildings due to the demand for potable water (Diehl de Souza & Ghisi, 2020). With rainwater harvesting, there are three water networks- potable, stormwater, and wastewater. These three networks can reduce the demand for potable water and reduce the stormwater runoff and the quantity of wastewater when they are combined with the greywater recycling systems (Semaan et al., 2020). One of the advantages of water demand reduction is the assurance of sufficient water supply for the population and economic growth (Nanle et al., 2022; Wijayanti et al., 2020). Having a rainwater harvesting infrastructure in the building could decrease the water stress on the groundwater due to stored rainwater that had been collected during rainy days.

However, the quality of rainwater arises because the water supply for rainwater harvesting is obtained through the accumulation of surface runoff from the roof. The quality of rainwater is influenced by several factors, i.e., the type of catchment area, conditions of topographic, climate, the air pollution level of the catchment area, the storage tank material, and the management of rainwater collection before it is used (Azis et al., 2021; Mukaromah, 2020). Nevertheless, the potential concern is mitigated because rainwater collecting is exclusively employed for domestic purposes, such as toilet flushing, household cleaning, and landscape irrigation, and so does not necessitate adherence to drinking water quality standards.

Greywater recycling

Besides rainwater harvesting, greywater recycling is the best solution for water scarcity and conservation (Radingoana et al., 2020). Greywater contributes to the largest water-saving in domestic residences as it promotes the preservation of high-quality freshwater, reduces environmental pollutants, and decreases the overall supply cost (Knutsson & Knutsson, 2021). Greywater can be defined as household wastewater that comes from both kitchen and bathroom sinks, showers, or baths and is the discharge from laundry activities where it can be reused, replacing the freshwater for non-potable activities such as toilet flushing and the irrigation of plants (Oh et al., 2018). According to Pradhan et al. (2019), greywater is lightly polluted and requires significantly less treatment for separating the organic loads in the wastewater and decreasing public health risks. Through greywater recycling, it can manage urban wastewater up to 10% to 50% of household water-saving.

In urban water scarcity, rainwater harvesting and greywater recycling are significant as they can be the alternative water source that can be collected, treated, and channelled for domestic usage (Zaharuddin I. S. & Ahmad N. A., 2022). In Malaysia, rainwater harvesting and greywater recycling are not commonly practised due to the limited resources and knowledge on their implementation and management, even though there is an extensive amount of both resources (Oh et al., 2018). However, both rainwater harvesting and greywater recycling have the potential to reduce the dependency of using freshwater for domestic usage. Hence this study is conducted to provide some positive views and references on the rainwater harvesting and greywater recycling system that can be implemented in office buildings and other buildings which give more benefits to the stakeholders, the occupants, the environment, and many other fields. As office buildings have more capacity usage during the day where activities such as washing, cleaning and praying are held more compared to the houses, the office buildings are perfect places for conducting the study. In addition, the volume of rainwater and greywater collected is higher than houses, as the roof area of the buildings is bigger and the number of occupants contributing to the greywater discharge from the office buildings during daytime.

RESEARCH METHODOLOGY

This study adopted a quantitative research design, focusing on the primary data that are collected from the building's control system (water collection and water consumption) and secondary data from the Monthly Green Building Reports that are provided by the contractor. The analysis is expected to explicate the potential benefits of integrating rainwater harvesting and greywater recycling in office buildings, as it can contribute to water conservation and give advantages to the environment.

Rainwater collection and consumption

The rainwater surface runoff from the roof is the primary source of rainwater harvesting. The amount of water that is collected depends on the size of the roof, whereby the larger the area, the more rainwater can be collected. In this study, the rainwater collection and consumption are monitored using the Building Control System of the building. All the surface runoff will be caught through the rainwater harvesting system using a siphon system where the maximum volume of water will be drawn into a trap and channelled to the rainwater harvesting tank. The rainwater harvesting tank is equipped with a water meter which is connected to the Building Control System. This water meter will record the water flow in and out of the rainwater harvesting tank, the volume of the water that is collected, and the volume of water that is pumped out for reuse for non-potable activities such as irrigation and toilet flush. The water movement is recorded every 15 minutes, 24 hours a day. The system will record the data automatically as it was set for every 15 minutes recording. Figure 1 illustrates how the rainwater harvesting system is applied and how the system works in the building.

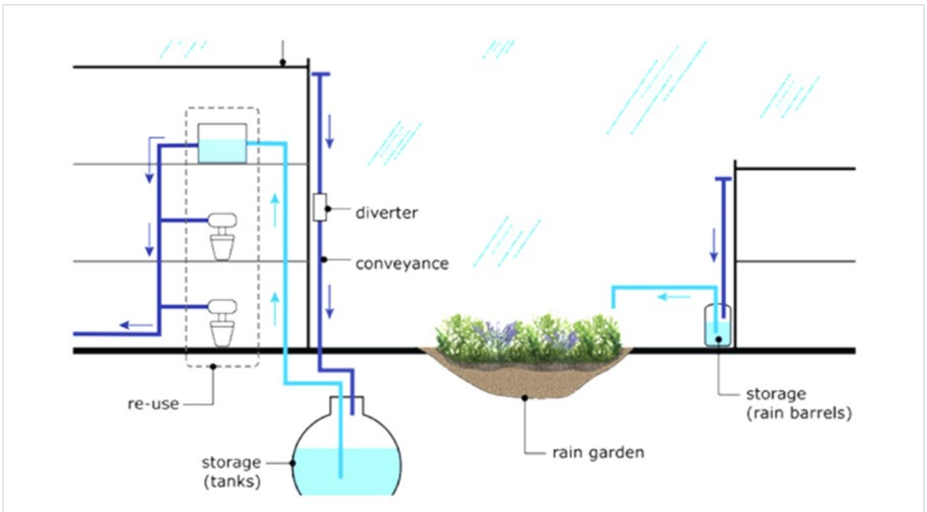


Figure 1: Rainwater Harvesting System in a Building
Source: Annual Technical Volume The Institution of Engineers (India) (2020)

Besides relying on the readings from the Building Control System, the collected rainwater can be calculated manually using a simple calculation. Table 1 shows the items that are needed for the manual calculation.

Table 1: Rainwater collection item needed for manual calculation

Item	Unit
Catchment area	m^2
Runoff coefficient	0.85
Duration	min

Table 1 illustrates the manual calculation of rainwater collection, which is expressed below as an equation:

$$\text{Rain water collection} = \frac{\text{Roof catchment area} \times (\text{runoff coefficient}) \times \text{duration}}{1000}$$

$$= \frac{Xm^2 \times 0.85 \times X\,\text{min}}{1000}$$

Greywater collection

Greywater also contributes to the reduction of freshwater usage for non-potable purposes. To mitigate potable water usage within the building, the greywater originating from the wash basin and ablution taps is gathered, subjected to treatment, and then stored for irrigation. In this study, greywater will be the main contributor. This is because the building has eleven stories of occupants in which the percentage of wash basin and ablution use is higher. All the greywater collected will be stored in a greywater tank in the building and treated before it is used for non-potable activities. Greywater collection can be calculated manually using a simple calculation. The items that are involved in the calculation are illustrated in Table 2.

Table 2: Rainwater collection item needed for manual calculation

Item	Unit
Daily consumption	m^3/day
Flow rate	L/min
Duration	m
Occupants	n
Water usage	L

From the items in Table 2, the manual greywater collection calculation can be expressed as an equation below:

$$\text{Greywater collection} = \frac{\text{Daily consumption x flow rate x duration x occupants x water used}}{1000}$$

-

$$= \frac{\text{day x L/min x min x n x L}}{1000}$$

Building Control System (BCS)

The Building Control System is a computerised, computer-based system that has been installed in a building that controls and monitors the mechanical and electrical equipment (Murdiana et al., 2019). In this study, the systems that have been controlled and monitored by the BCS are the rainwater harvesting system and greywater recycling system for irrigation and toilet flushing. According to Muna (2019), a water meter is installed in both the rainwater harvesting and greywater tanks to monitor the volume of water that is collected and reused. This water meter is mechanical and connected to the BCS, where it is computer-based. The data on the water flow will be recorded in the system. Using the BCS is helpful for the engineer for easy monitoring. This study's rainwater harvesting and greywater recycling data are downloaded from the BCS as the primary data.

Green Building Monthly Report

The building for this case study is one of the green buildings that implement both the rainwater harvesting system and greywater recycling concurrently. As a green building, the contractor that manages the building maintenance needs to produce a monthly report as a record for green building points. The monthly report is used as the secondary data to support the primary data.

RESULT AND DISCUSSION

Volume of water collection

Rainwater harvesting capacity

The study on the rainwater harvesting system was conducted for two months to observe the effectiveness of rainwater collection and its reuse for non-potable activities. The data are from the Building Control System, which monitors every fifteen (15) minutes and twenty-four (24) hours daily. Figure 2 shows the volume of collected rainwater in two months.

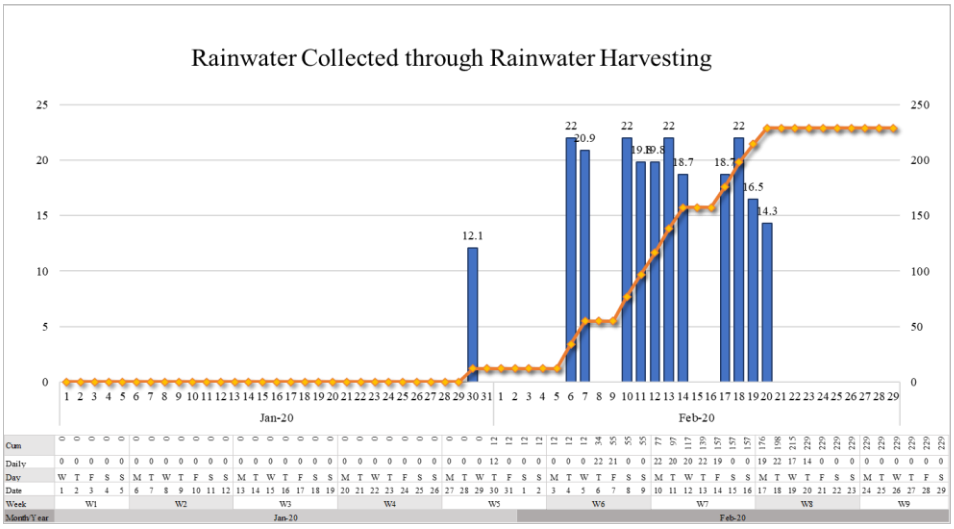


Figure 2: The volume of rainwater collected in Jan 2020 and Feb 2020

From the figure, the total rainwater that has been collected through the rainwater harvesting system in January 2020 was only 12.1m^3. This is due to the dry and sunny weather. In February 2020, the rainwater that is collected through the rainwater harvesting system has increased to 216.7m^3. The total volume of rainwater collected is 228.8m^3.

Greywater capacity

There are a few numbers of sources for greywater collection. This study's main sources for greywater collection are the wash basins and ablution. The Building

Control System also records all the greywater that has been collected. The capacity of greywater is collected daily. Figure 3 illustrates the total volume of collected greywater from both sources, i.e., wash basins and ablution, for January 2020 and February 2020.

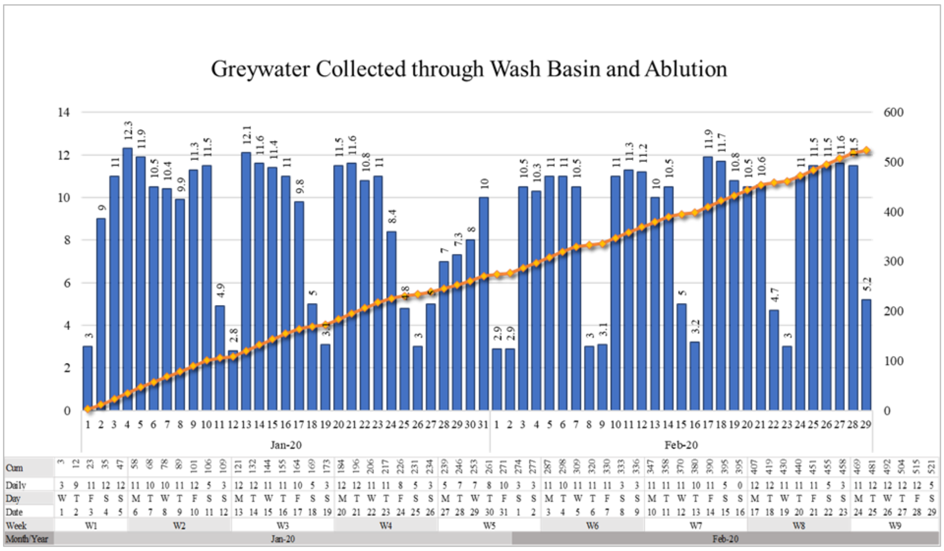


Figure 3: The volume of greywater collected in Jan 2020 and Feb 2020

In January 2020, 270.9m^3 of greywater was collected from the wash basin and ablution. The greywater was collected on a daily basis, including Saturdays, Sundays, and public holidays. For February 2020, the total greywater collected is 249.7m^3. This total water collected has brought to the cumulative volume of greywater collected in two months, which is 520.6m^3.

Volume of water consumption

SYABAS water supply

The potable water or freshwater supply to the building is mainly from Syarikat Bekalan Air Selangor or SYABAS. Every day, the water supply to the building's water tank will be recorded by the Building Control System (BCS). Figure 4 illustrates the volume of freshwater supply into the water tank for January 2020 and February 2020. There was 1568.5m^3 of freshwater supplied in January 2020 and 1571.3m^3 in February 2020. This totals 3139.8m^3 of freshwater that has been supplied for the building in both months. This freshwater is mainly used for potable drinking, cleaning, and other activities. But from the 3139.8m^3 of freshwater, only 1924.3m^3 is used. The rest has remained in the building's water tank. Figure 5 illustrates the domestic use of freshwater in January 2020 and February 2020.

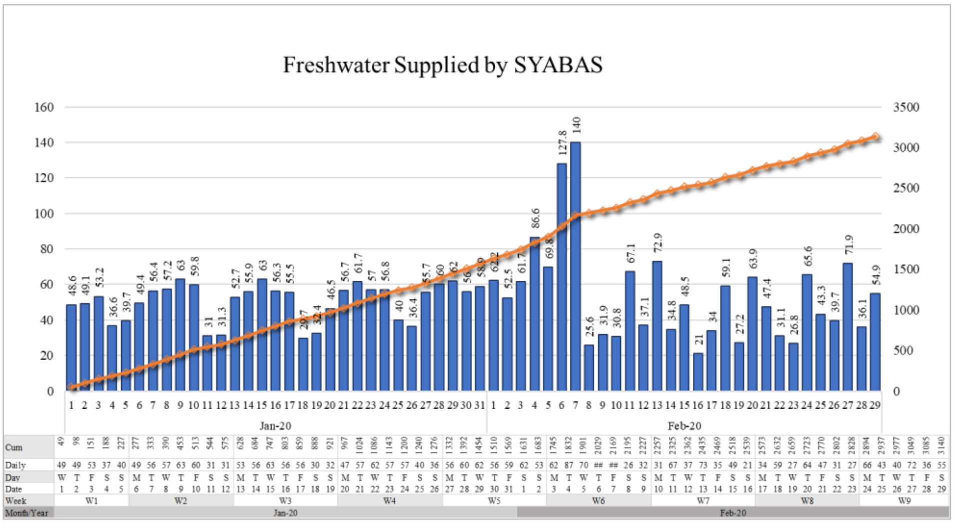


Figure 4: The volume of freshwater supplied by SYABAS in Jan 2020 and Feb 2020

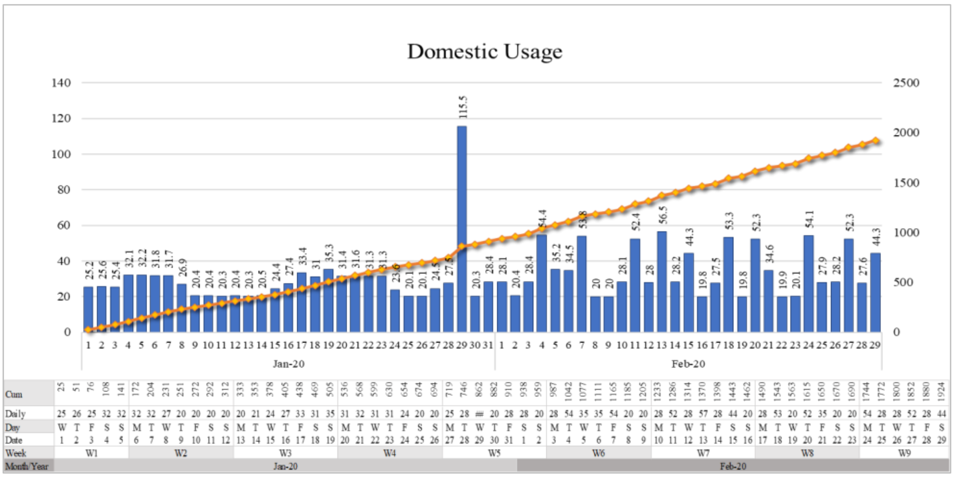


Figure 5: The volume of freshwater usage for domestic purposes in Jan 2020 and Feb 2020

Rainwater and greywater are reused and recycling

The collected rainwater and greywater were used for purposes of irrigation and toilet flushing. Greywater will be treated first before it is reused, mainly for irrigation; this is to reduce the chemicals in the greywater source that is from wash basins and ablutions where the tendency of using chemicals during cleaning is high. It is also to avoid any harm to the plants and soil. Table 3 shows the weekly water collection and consumption in the building for January 2020 and February 2020.

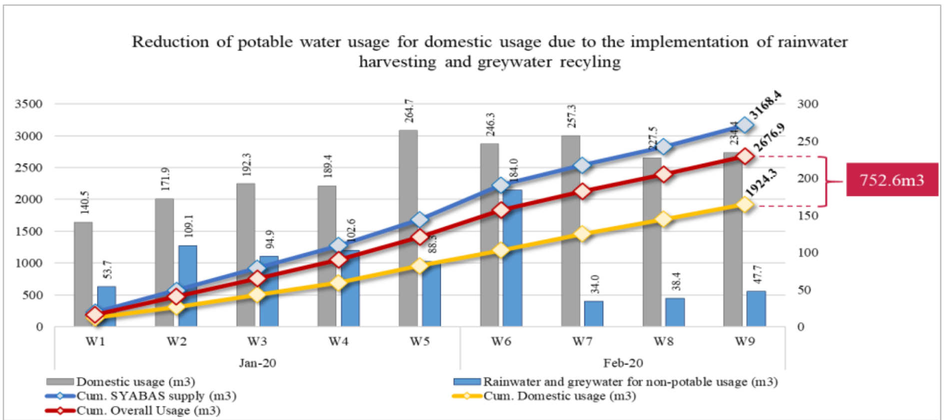
Table 3: Weekly water collection and consumption

Month	Week	SYABAS supply (m^3)	Domestic Usage (m^3)	Rainwater and greywater for non-potable usage (m^3)
Jan 20	W1	227.2	140.5	53.7
	W2	348.1	171.9	109.1
	W3	345.5	192.3	94.9
	W4	355.1	189.4	102.6
	W5	407.3	264.7	88.3
Feb 20	W1	543.4	246.3	184.0
	W2	312.2	257.3	34.0
	W3	289.5	227.5	38.4
	W4	311.5	234.4	47.7
Total		3139.8	1924.3	752.6

Table 3 shows the decreasing volume of potable water consumption for domestic use compared to the freshwater supply from SYABAS. Rainwater and greywater recycling have contributed 28.11% of the total water consumption for potable and non-potable activities. It has reduced freshwater consumption and automatically saved building expenses in the long term. Even though rainwater and greywater recycling are at the initial stage of building operation, the effectiveness of using rainwater and greywater as substitutes for freshwater for non-potable activities is evident.

Freshwater saving and water efficiency

Figure 6 shows the patterns of collected rainwater and greywater, freshwater that is supplied by SYABAS, the volume of recycled rainwater and greywater, and how much freshwater can be saved when rainwater harvesting and greywater recycling is being implemented in office buildings. The graph indicated that 752.6m^3 of freshwater can be saved in these two months. This result might give a positive outcome where more freshwater can be saved for months or through the years, and will indirectly overcome the shortage of freshwater sources when more buildings implement these systems on their premises. As Malaysia is a country with a tropical climate, rainwater can be collected throughout the year, hence, rainwater availability is not an issue for the implementation of the system. Besides, Malaysia has at least five working days every week, thus, greywater would not become an issue for the system either.



Total usage (m3)	194.2	281.0	287.2	292.0	353.0	430.3	291.3	265.9	282.1	2676.9
Rainwater & greywater for non-portable usage (m3)	53.7	109.1	94.9	102.6	88.3	184.0	34.0	38.4	47.7	752.6
Domestic usage (m3)	140.5	171.9	192.3	189.4	264.7	246.3	257.3	227.5	234.4	1924.3
SYABAS supply	227.2	348.1	345.5	355.1	407.3	543.4	312.2	289.5	311.5	3139.8
Week	W1	W2	W3	W4	W5	W6	W7	W8	W9	Total
Month/Year	Jan-20					Feb-20				

Figure 6: The volume of freshwater usage for domestic purposes in Jan 2020 and Feb 2020

The office buildings' rainwater harvesting, and greywater recycling are functioning by collection of the rain by a siphonage system that is installed on the roof of the buildings. All the rainwater will be going a full-blast suction, which will then be channelled by siphonage piping into the rainwater harvesting tank. Meanwhile, in the buildings, all the buildings, all the greywater discharge from the wash basin and ablution will be collected and stored in the greywater tank that is located at the bottom of the buildings. The greywater will then be treated until it can safely be used for toilet flushing and irrigation purposes.

It has been estimated that more than 3000m^3 of freshwater can be saved in a year when the systems run smoothly in the buildings. The amount is enough to grant the whole buildings of green building points underwater efficiency. Water efficiency can be described as reducing water usage and minimising wastewater discharge. Water efficiency emphasises the responsibility of using freshwater cautiously and conserving it for future generations. In this scenario, it means that freshwater can only be consumed for the most reasonable purposes, such as cooking, drinking, and other activities that really need freshwater to avoid any harm and to replace freshwater consumption for non-potable activities with other alternatives whereby in this study is the substitution through reusing and recycling rainwater and greywater for non-potable activities.

Furthermore, rainwater harvesting, and greywater recycling can reduce the amount of wastewater that is discharged to the environment. This is because some of the wastewater, which is greywater from wash basins and ablution, will be collected in order to be reused for toilet flushing and irrigation. The lesser the amount of wastewater that is being discharged into the environment, the cleaner the environment, and this will contribute to the reduction of water source pollution, which are the rivers. This circumstance aligns with Sustainable Goal Development 6: clean water and sanitation. In the long term, if the systems are well-implemented and well-maintained, the goal can be achieved quickly, the earth will have a sufficient freshwater supply for future generations, and we can have more water at the drinking level. The systems can be seen as an environmentally friendly method where, as we know, rainwater is safe to be used for irrigation due to lesser chemicals that are contained in the molecules. As such, rainwater can conserve energy compared to the regular potable water that is needed. In addition, lesser energy usage to power the water will make it a tremendous appreciation of nature.

CONCLUSION

Rainwater harvesting and greywater recycling are considerably new in Malaysia. Most buildings' management only considers either rainwater harvesting systems or greywater recycling, and not both systems. This is believed to be due to the high initial cost of installation and maintenance of mechanical equipment. But for the long term, implementing both systems will benefit and profit the stakeholders of the building because of the high returns in potable water consumption and water savings. It can be concluded that when both systems are implemented together in a building, the potable water consumption for non-potable activities is reduced, and besides reducing freshwater usage, it increases the water efficiency due to the recycling of rainwater and greywater, conserve the freshwater and reduce the volume of wastewater discharge to the environment. These are crucial elements as freshwater is becoming scarce. Thus, prompt implementation of the systems, especially in office buildings, will contribute to a better future. As suggested, the systems can be required for newly constructed buildings, especially those with large roof areas and high occupant capacity. The systems can be one of the potential alternatives to overcome water wastage and indirectly avoid more untreated wastewater discharge to the environment. In the future, the stakeholders can consider applying both systems in their premises for a better lifestyle, especially in controlling freshwater consumption and eventually solving the freshwater crisis.

REFERENCES

Al-Batsh, N., Al-Khatib, I. A., Ghannam, S., Anayah, F., Jodeh, S., Hanbali, G., Khalaf, B., & van der Valk, M. (2019). Assessment of rainwater harvesting systems in poor rural communities: A case study from Yatta Area, Palestine. *Water (Switzerland)*, *11*(3), 1–15. https://doi.org/10.3390/w11030585

Azis, S. S. A., Razali, M. N. B. M., Maimun, N. H. A., Yusoff, N. S. M., Rahman, M. S. A., Zulkifli, N. A. A., & Real. (2021). An Analysis on the Efficiency of Green Roof in Managing Urban Stormwater Runoff. *Planning Malaysia*, *19*(3), 111–122.

Chi, B., Lu, W., Ye, M., Bao, Z., & Zhang, X. (2020). Construction waste minimization in green building: A comparative analysis of LEED-NC 2009 certified projects in the US and China. *Journal of Cleaner Production*, *256*, 120749. https://doi.org/10.1016/j.jclepro.2020.120749

Diehl de Souza, T., & Ghisi, E. (2020). Harvesting rainwater from scaffolding platforms and walls to reduce potable water consumption at buildings construction sites. *Journal of Cleaner Production*, *258*, 120909. https://doi.org/10.1016/j.jclepro.2020.120909

Knutsson, J., & Knutsson, P. (2021). Water and energy savings from greywater reuse: a modelling scheme using disaggregated consumption data. *International Journal of Energy and Water Resources*, *5*(1), 13–24. https://doi.org/10.1007/s42108-020-00096-z

Lani, N. H. M., Yusop, Z., & Syafiuddin, A. (2018). A review of rainwater harvesting in Malaysia: Prospects and challenges. *Water (Switzerland)*, *10*(4), 1–21. https://doi.org/10.3390/w10040506

Mukaromah, H. (2020). Rainwater Harvesting as an Alternative Water Source in Semarang, Indonesia: The Problems and Benefits. *IOP Conference Series: Earth and Environmental Science*, *447*(1). https://doi.org/10.1088/1755-1315/447/1/012059

Murdiana, A. W., Soesilo, T. E. B., & Bismo, S. (2019). Feasibility study of rainwater conservation and harvesting for industrial community in North Jakarta. *IOP Conference Series: Earth and Environmental Science*, *311*(1). https://doi.org/10.1088/1755-1315/311/1/012056

Nanle, V. Y., Latip, N. A., & Karim, R. (2022). Resident's Water Accessibility Towards Sustainability: the Case of Informal Settlements of Jos Metropolis, Nigeria. *Planning Malaysia*, *20*(4), 87–100. https://doi.org/10.21837/pm.v20i23.1153

Oh, K. S., Leong, J. Y. C., Poh, P. E., Chong, M. N., & Lau, E. Von. (2018). A review of greywater recycling related issues: Challenges and future prospects in Malaysia. *Journal of Cleaner Production*, *171*, 17–29. https://doi.org/10.1016/j.jclepro.2017.09.267

Pradhan, S., Al-Ghamdi, S. G., & Mackey, H. R. (2019). Greywater recycling in buildings using living walls and green roofs: A review of the applicability and challenges. *Science of the Total Environment*, *652*, 330–344. https://doi.org/10.1016/j.scitotenv.2018.10.226

Radingoana, M. P., Dube, T., & Mazvimavi, D. (2020). Progress in greywater reuse for home gardening: Opportunities, perceptions and challenges. *Physics and Chemistry of the Earth*, *116*(February 2019), 102853. https://doi.org/10.1016/j.pce.2020.102853

Şahin, N. İ., & Manioğlu, G. (2019). Water conservation through rainwater harvesting using different building forms in different climatic regions. *Sustainable Cities and Society*, *44*, 367–377. https://doi.org/10.1016/j.scs.2018.10.010

Semaan, M., Day, S. D., Garvin, M., Ramakrishnan, N., & Pearce, A. (2020). Optimal sizing of rainwater harvesting systems for domestic water usages: A systematic literature review. *Resources, Conservation and Recycling: X*, *6*, 100033. https://doi.org/10.1016/j.rcrx.2020.100033

Shaharudin, M. S., Ganesan, Y., Fernando, Y., & Haron, H. (2022). Green Technology Adoption in Malaysia: Where Are We Now? What Is Lacking? & What Should We Do Next? *Journal of Information System and Technology Management*, *7*(27), 109–121. https://doi.org/10.35631/jistm.727009

The Institution of Engineers (India). (2020). *Advances in Soil and Water Conservation Engineering* (Vol. 4).

Wijayanti, Y., Fittkow, M., Budihardjo, K., Purwadi, & Setyandito, O. (2020). Sustainable water management: A review study on integrated water supply (case study on special district of Yogyakarta). *IOP Conference Series: Earth and Environmental Science*, *426*(1). https://doi.org/10.1088/1755-1315/426/1/012056

Yoonus, H., & Al-Ghamdi, S. G. (2020). Environmental performance of building integrated grey water reuse systems based on Life-Cycle Assessment: A systematic and bibliographic analysis. *Science of the Total Environment*, *712*, 136535. https://doi.org/10.1016/j.scitotenv.2020.136535

Zaharuddin I. S., & Ahmad N. A. (2022). Effectiveness of Rainwater Harvesting System as Domestic use at Public University in Malaysia: A Review MALAYSIA *Corresponding Author Designation. *Recent Trends in Civil Engineering and Built Environment*, *3*(1), 1462–1473. http://publisher.uthm.edu.my/periodicals/index.php/rtcebe

Received: 26th June 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 267 – 282

A PRELIMINARY FRAMEWORK FOR PREVENTING DISPUTES IN DIFFERENT STAGES OF BUILDING CONSTRUCTION PROJECTS

Nur Nadhirah Muhammuddin[1], Mohd Suhaimi Mohd-Danuri[2]*, Mahanim Hanid[3], Fadzida Ismail[4], Mohd Nasrun Mohd Nawi[5]

[1,2,3]*Centre for Building, Construction & Tropical Architecture, Faculty of Built Environment,* UNIVERSITI MALAYA
[4]*Faculty of Industrial Management,* UNIVERSITI MALAYSIA PAHANG
[5]*School of Technology Management and Logistics,* UNIVERSITI UTARA MALAYSIA

Abstract

The upward trend of dispute claims and occurrences throughout different stages has detrimentally affected the outcomes of construction projects. Building upon two major themes from a systematic literature review (SLR) study, Principal Component Analysis (PCA) was performed to further group the extensive causes and strategies into several meaningful groups using the Statistical Social Package Science (SPSS) software. Questionnaires were used and issued to three main stakeholders (clients, consultants, and contractors) in the Klang Valley area. This paper presents the PCA findings, which have led to the development of a framework to prevent disputes in different stages of building construction projects. The PCA findings have narrowed down the major contributors of disputes to “Contract-related causes” and “Time-related causes”. PCA analysis has also shown that the three key themes of “Quality-related strategies,” “Business relationship-related strategies,” and “Productivity-related strategies” were the most effective ways to reduce disagreements. It is important to highlight that the findings related to the causes of disputes during the planning stage consistently align with those of a prior study. This underscores the importance of ethical conduct, particularly during the planning phase and, more specifically, within the tendering process.

Keywords: building construction projects, disputes, minimising, strategy

[2] Associate Professor at UM. Email: msuhaimi@um.edu.my

INTRODUCTION

Soni et al. (2017) claimed that conflicts and disputes can happen at any stage of a project lifecycle, which can affect its pre-planned schedule, and adversely affect the construction cost, project delivery, and the overall project performance. Following this perspective, several studies (Ayudhya, 2011; Assaf et al., 2019; Cakmak & Cakmak, 2014; El-Sayegh et al., 2020) have classified the causes of disputes based on their common relationships, or by construction stages, or based on the individuals that started the disputes. The results of this study on a framework design that could reduce disputes at various stages of building construction projects are presented in this paper. This study has explored construction disputes by thoroughly assessing the causes and the potential strategies to minimise disputes in construction projects. This study has specifically focused on building projects in Malaysia based on a systematic literature review (SLR) conducted by Muhammuddin et al. (2022) and has identified two major themes. Table 1 lists these themes, namely, causes of disputes and strategies to minimise the dispute, which serve as a theoretical base for the development of the framework to minimise the occurrences of construction dispute in building projects, throughout the project phases. This framework is designed in accordance with the project phases outlined by Project Management Institute (PMI, 2017).

Table 1: Summary of SLR findings on causes of dispute and strategies to minimize them (Muhammuddin et. al, 2022)

Project Phases	Causes of dispute	Strategies to minimise dispute
Initiation	Poor estimation practices during feasibility study, unrealistic project planning, poor and ineffective communication between parties in the project	Established a clear definition of project scope, preserve a good relationship between the project team members
Planning	Poor estimation practices, unrealistic project planning, delay in obtaining permit or approval from the municipality and the other governmental authorities, inadequate design information, design errors, poor quality design, inconsistencies between the drawings and specifications, short time available during design stage, inadequate and incomplete specification, poor and ineffective communication between parties in the project, ambiguities in the contract documents, types of procurement method adopted, misinterpretation of contract documents, different interpretations of the contract provisions, lack of understanding and	Execute proper risk allocation, allocate adequate time to prepare for contract documentations, efficient communication, early detection of problems, provide timely resolution for problems, developed trust between parties, developed teamwork between parties, developed long term relationship between parties, select an experienced contractor to undertake the project, contractors should not take the projects beyond their technical capabilities, clients should be punctual in giving instructions, consultants to prepare clear and comprehensive documentation, selecting a professional

Project Phases	Causes of dispute	Strategies to minimise dispute
	agreement on the type of contract, incorrect pricing of the works, unfair risk allocation, selection of contractors based on the low bid only without considering the technical capabilities.	construction team, quality control checking before issuance of documents, record keeping, ensure full understanding of the contract requirements prior signing of agreement, client to prepare effective project planning, preserve a good relationship between the project team members, adoption of digital technology to facilitate coordination and early detection of problems
Execution, Monitoring and Controlling	Variation orders, change of material specification, unforeseen ground conditions, failure of the client to honour payments as and when due, time overrun, cost overrun, poorly drafted or incomplete and unsubstantiated claims, failure to make interim awards on extension of time and compensation, failure of the major stakeholders in understanding and complying with the contractual obligations, failure to properly administered the contract, mishandle the construction process, poor quality of work, late giving of site possession, delay in work progress, technical inadequacy, unrealistic contract duration, labour inefficiencies, inadequate contractor's experience, ineffective planning and scheduling of project by contractor, unavailability of cash flow faced by contractor, request for project acceleration, poor productivity, disagreement over scope variation, delay in issuing site drawings and materials, materials damaged during storage, late instruction by the employer, poor and ineffective communication between the parties in the project, breach of contract, unrealistic expectation of the client, change in rate due to quantity variations, change in material source and it cost	Efficient communication, early detection of problems, provide timely resolution for problems, developed trust between parties, developed teamwork between parties, preserve a good relationship between the project team members, clients should avoid making unnecessary variations, clients should be punctual in giving instructions, proper record keeping, proper payment schedule, payment as at when due, adoption of digital technology to facilitate coordination and early detection of problems
Closeout	Defects	-

RESEARCH METHODOLOGY

Built upon the findings of the SLR study by Muhammuddin et al. (2022), this study has analysed the returned questionnaires using the Principal Component

Analysis (PCA) to categorise the extensive causes and strategies into several meaningful groups. Similar to the study by Mohd-Nordin (2023), the targeted respondents were clients, consultants, and contractors (Grade 7) within the Klang Valley area. The lists of potential respondents were extracted from respective associations and professional bodies, such as the Real Estate and Housing Developers' Association Malaysia, the Construction Industry Development Board (CIDB), the Board of Architects Malaysia, and the Board of Quantity Surveyors Malaysia, which resulted in a total population of 1,896.

Based on the sample size determination table by Cohen et al. (2007), 322 questionnaire surveys were distributed, and 96 responses were received, which accounted for 29.8% response rate. Prior to distributing the questionnaires, a pilot study was conducted to ensure its clarity and effectiveness. The questionnaire consisted of Likert-scale questions and open-ended questions.

FINDINGS AND DISCUSSION

Principal Component Analysis (PCA)

The PCA is a statistical procedure that is used to reduce a large number of variables into several components by forming clusters that reflect the core of the original data (Adegbembo et al., 2020; Hadi et al., 2016; Karji et al., 2020). The PCA was used in this study to further identify and cluster the obtained variables into specific groups to describe the pattern of correlations within a similar set of variables. Subsequently, more meaningful findings and comprehensive insights were found for the framework's development. Examples of PCA application can be found in several construction industry-related research works, such as by Dogbegah et al. (2011), Karji et al. (2020), Saar et al. (2017), Sakyiama (2016), and Treacy et al. (2015). The PCA was conducted using IBM Statistical Package for Social Sciences (SPSS) software, version 28.

According to Pallant (2013), two appropriateness tests must be performed to evaluate the sample size and the relationship strength between the variables before conducting the PCA. The former can be determined using the Kaiser-Meyer-Olkin (KMO) test, while the latter can be tested using Bartlett's test of sphericity (Hadi et al., 2016). The KMO sampling adequacy of 0.50 and above was acceptable for this research (Kissi et al., 2016; Obeng-Ahenkora & Danso, 2018; Omaraka, 2020). Meanwhile, the Bartlett's test of sphericity must indicate a significant value of less than 0.05 (Field, 2005; Pallant, 2013). These tests were repeatedly performed on the data for each project phase. Communalities must also be established. Dogbegah et al. (2011) explained that communalities are the total amount of variances that the initial variables share with the other variables in the set of data. There are various views on the ideal value of communalities. However, this study has adopted the proposed 0.50 value by Field (2005), Dogbegah et al. (2011), and Omaraka (2020) as the minimum communalities score.

Next, the collected data were analysed using the PCA with varimax rotation to ensure that each component was uncorrelated. Then, the principal components were determined using the eigenvalue test. As proposed by Karji et al. (2020), components with an eigenvalue of greater than 1.0 were selected to determine the principal components. Since some of the variables were quite large, for ease of reporting, the research findings presented in the relevant tables in the following sections have been set to display only those components with an eigenvalue of greater than 1.0. The rotated component matrix provided a better understanding of the principal components, as it clarified the theme represented by each principal component through the indication of the associated variables. These tests were conducted repeatedly for every set of data in each phase of construction. The findings and discussions in the next sections have been organised in the following order: causes of dispute and strategies to reduce dispute.

Causes of Dispute

The KMO and Bartlett's results for all phases regarding the causes of dispute indicated that this data set was appropriate for PCA, as this set passed the minimum sampling adequacy of 0.50 and a p-value of less than 0.001, respectively. The communalities values for all phases also reached the pre-determined cut-off of 0.50. In this section, only one cause of dispute would be listed under the closeout phase. Therefore, this cause was excluded from the PCA because no correlation can be calculated with only one variable. The following Table 2 presents the eigenvalue and component matrix for the respective project phases listed in Table 1.

Initiation Phase

Table 2 shows that only one component has an eigenvalue of greater than 1.0. Thus, rotation was not conducted.

Table 2: Total variance explained for causes of dispute during the initiation phase

Component (C)	Initial Eigenvalues (IE)			Extraction Sums of Squared Loadings (ESSL)		
	Total (T)	% of Variance (% Var)	Cumulative % (Cum %)	Total (T)	% of Variance (% Var)	Cumulative % (Cum %)
1	1.989	66.303	66.303	1.989	66.303	66.303
2	.619	20.635	86.937			
3	.392	13.063	100.000			

To further understand the variables related to this component, the results of the component matrix in Table 3 have been analysed. This table shows that all causes listed under the initiation phase are significantly related to Component 1. Based on the analysis of the three variables associated with it, Component 1 was themed as **"Developing business case–related causes"**, since these variables were closely related to the development of the business case, which would be undertaken during the initiation phase.

Table 3: Component matrix for causes of dispute during the initiation phase

Causes of dispute during the initiation phase	Component
	1
Poor estimation practices during feasibility study	.862
Unrealistic project planning	.825
Poor and ineffective communication between parties in the project	.752
Extraction Method: Principal Component Analysis.[a]	
a. 1 components extracted.	

Planning Phase

Table 4 summarises the five principal components of the causes of dispute that have been extracted for the planning phase, as they have greater values than the eigenvalue set in this research.

Table 4: Total variance explained for causes of disputes during the planning phase

C	IE			ESSL			Rotation Sums of Squared Loadings (RSSL)		
	T	% of Var	Cum %	T	% of Var	Cum %	T	% of Var	Cum %
1	6.899	38.325	38.325	6.899	38.325	38.325	4.298	23.877	23.877
2	1.951	10.839	49.165	1.951	10.839	49.165	3.219	17.882	41.759
3	1.645	9.138	58.303	1.645	9.138	58.303	1.834	10.186	51.946
4	1.068	5.931	64.233	1.068	5.931	64.233	1.765	9.807	61.752
5	1.028	5.712	69.945	1.028	5.712	69.945	1.475	8.193	69.945

Table 5 presents the results of the rotated component matrix that can describe the correlations between each variable and its components. Several observations were made to determine which variables produce the highest factor loadings. The higher the factor loadings of the variable, the stronger its correlation with the components, which can reveal the clusters to which the variables belong to. Evidently, Component 1 has the highest variance (38.33%), which inferred that all variables under this component were the critical causes of dispute during the planning phase. All six variables were related to design issues;

thus, Component 1 was given the theme of **"Design and specification-related causes"**. Meanwhile, the variables in Component 2 were closely related to contractual matters; thus, they were clustered under the theme of **"Contract-related causes"**, and Component 3 was assigned the **"Procurement-related causes"** theme, as it was strongly linked to procurement processes. Component 4 was relatively simple to understand, as both variables were associated with contract pricing. Hence, this component was themed as **"Contract pricing-related causes"**. Lastly, Component 5 was assigned with the theme of **"Time-related causes"**, as the variables were interrelated with time-related issues.

Table 5: Rotated component matrix for causes of dispute during the planning phase

Causes of dispute during the planning phase	**Components**				
	1	**2**	**3**	**4**	**5**
Poor estimation practices	.492	.162	.653	-.026	.163
Unrealistic project planning	.442	-.021	.672	.011	.272
Delay in obtaining permit or approval from the municipality and the other governmental authorities	-.032	-.002	.074	.125	.886
Inadequate design information	.710	.264	.001	.200	.188
Design errors	.847	-.013	.132	.152	.048
Poor quality design	.851	.124	.116	-.051	.119
Inconsistencies between the drawings and specifications	.743	.233	.136	.330	-.147
Short time available during design stage	.410	.128	.107	.048	.435
Inadequate and incomplete specification	.719	.359	.095	.158	.013
Poor and ineffective communication between parties in the project	.484	.355	.257	.018	-.052
Ambiguities in the contract documents	.504	.613	.239	.145	-.114
Types of procurement method adopted	.049	.453	.184	.333	.497
Misinterpretation of contract documents	.204	.856	.069	-.010	.088
Different interpretations of the contract provisions	.101	.891	.083	.111	.069
Lack of understanding and agreement on the type of contract	.247	.742	-.011	.304	.100
Incorrect pricing of the works	.207	.033	.237	.828	.121
Unfair risk allocation	.164	.317	.013	.718	.160
Selection of contractors based on the low bids only without considering their technical capabilities	-.059	.152	.809	.331	-.011
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalisation. a. Rotation converged in 7 iterations.					

Execution, Monitoring, and Controlling Phase

Table 6 shows that for the execution, monitoring, and controlling phase, the computation has yielded seven principal components with eigenvalues of greater than 1.0.

Table 6: Total variance explained for causes of disputes during the execution, monitoring and controlling phase

C	IE			ESSL			RSSL		
	T	% of Var	Cum %	T	% of Var	Cum %	T	% of Var	Cum %
1	10.588	34.155	34.155	10.588	34.155	34.155	4.852	15.651	15.651
2	2.821	9.100	43.255	2.821	9.100	43.255	3.331	10.745	26.396
3	2.083	6.719	49.974	2.083	6.719	49.974	3.029	9.770	36.166
4	1.599	5.158	55.132	1.599	5.158	55.132	2.721	8.778	44.945
5	1.488	4.798	59.930	1.488	4.798	59.930	2.701	8.714	53.659
6	1.379	4.448	64.379	1.379	4.448	64.379	2.293	7.396	61.054
7	1.142	3.682	68.061	1.142	3.682	68.061	2.172	7.007	68.061

According to the rotated component matrix in Table 7, the causes of dispute during this phase can be grouped into seven clusters. There were eight variables with high correlations with Component 1. These variables were directly related to contractual issues, resulting in Component 1 being themed as **"Contract-related causes"**. Next, all variables under Component 2 can be linked under the theme of **"Contractor's competencies and capabilities-related causes"**, while the third principal component was clustered as **"Client-related causes"** because of their variables' direct relation to clients' affairs. With variables highly related to cost adjustment issues, Component 4 was labelled as **"Disagreement on cost adjustment-related causes"**, whereas Component 5 was themed as **"Change request and claims-related causes"**. After analysing the characteristics of the variables in Component 6, it was labelled as "**Time-related causes"**, as the variables were strongly connected to time-related problems. Finally, due to their characteristics and strong interaction with project risks and issues of uncertainty, the three variables in Component 7 were assigned under the theme of **"Project risk and uncertainties-related causes".**

Table 7: Rotated component matrix for causes of disputes during the execution, monitoring, and controlling phase

Causes of dispute during execution, monitoring, and controlling phase	Components						
	1	2	3	4	5	6	7
Variation orders	.084	.265	.153	.196	.728	-.070	.094
Changes in material specification	-.049	.084	-.025	.410	.663	.233	.177
Unforeseen ground conditions	.107	.032	-.129	.244	.043	.339	.681
Failure of the client to honour payments as and when due	.163	.102	.831	.063	-.015	-.038	.155
Time overruns	.163	.250	.306	-.038	.239	-.048	.745
Cost overruns	.202	.170	.434	.109	.255	-.100	.653
Poorly drafted or incomplete and unsubstantiated claims	.354	.011	.163	.365	.466	.085	-.045
Failure to make interim awards on the extension of time and compensation	.253	-.003	.801	-.009	.087	.165	.029

Causes of dispute during execution, monitoring, and controlling phase	**Components**						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Failure of the major stakeholders in understanding and complying with their contractual obligations	.792	-.051	.143	.108	.127	.205	.124
Failure to properly administer the contract	.774	.350	.176	-.046	.107	.103	.009
Mishandling the construction process	.679	.371	.047	.087	.045	.320	.149
Poor quality of work	.485	.177	-.107	.024	.636	.217	.176
Lateness in giving of site possession	.143	.059	.192	.044	.196	.776	.101
Delay in work progress	.072	.368	.118	-.026	.531	.353	.242
Technical inadequacy	.428	.519	-.009	-.014	.274	.374	.234
Unrealistic contract duration	.300	.252	.297	.263	.180	.163	.276
Labour inefficiencies	-.091	.471	-.182	.413	.044	.283	.341
Contractor’s inadequate experience	.259	.650	.146	-.034	.159	.092	.072
Ineffective planning and scheduling of the project by the contractor	.280	.698	.055	.135	.095	-.048	-.013
Unavailability of cash flow faced by the contractor	.006	.636	.139	.382	.068	-.110	.156
Request for project acceleration	-.031	.328	.464	.380	.120	.484	-.082
Poor productivity	.163	.601	-.034	.093	.333	.239	.179
Disagreement over scope variation	.660	.041	.294	.229	.124	-.154	.242
Delay in issuing site drawings and materials	.548	-.059	.266	.267	.315	.361	.146
Materials damaged during storage	.113	.482	.061	.434	-.064	.456	.033
Late instruction by the employer	.251	.052	.580	.214	.195	.412	-.003
Poor and ineffective communication between the parties in the project	.720	.179	.127	.113	.207	.028	.020
Breach of contract	.773	.226	.175	.021	-.155	-.117	.025
Unrealistic expectation of the client	.393	.091	.521	.365	-.140	.130	.324
Changes in rate due to quantity variations	.225	.174	.085	.779	.192	-.005	.123
Changes in material source and cost	.112	.129	.168	.782	.275	.133	.073
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalisation. a. Rotation converged in 22 iterations.							

Strategies to Minimise Dispute
Initiation Phase

Table 8 shows that only one component has an eigenvalue of greater than 1.0 under the initiation phase.

Table 8: Total variance explained for strategies to minimise dispute during the initiation phase

C	**IE**			**ESSL**		
	T	**% of Var**	**Cum %**	**T**	**% of Var**	**Cum %**
1	1.552	77.624	77.624	1.552	77.624	77.624
2	.448	22.376	100.000			

Table 9 shows that both variables have a strong correlation with Component 1. Thus, Component 1 was assigned the theme of **"Developing business case-related strategies"** because business case development was among the activities performed during the initiation phase (PMI, 2017). The strategies listed during this phase were also highly relevant to be practised during the abovementioned activity.

Table 9: Component matrix for strategies to minimise dispute during the initiation phase

Strategies to minimise dispute during the initiation phase	**Component**
	1
Established a clear definition of project scope	.881
Preserve a good relationship between the project team members	.881
a. 1 components extracted.	

Planning Phase

Table 10 summarises the total variance that can be explained for this data set with five principal components because they have an eigenvalue of greater than 1.0.

Table 10: Total variance explained for strategies to minimise dispute during the planning phase

C	**IE**			**ESSL**			**RSSL**		
	T	**% of Var**	**Cum %**	**T**	**% of Var**	**Cum %**	**T**	**% of Var**	**Cum %**
1	7.474	39.334	39.334	7.474	39.334	39.334	3.030	15.946	15.946
2	2.053	10.807	50.141	2.053	10.807	50.141	2.910	15.318	31.264
3	1.340	7.053	57.194	1.340	7.053	57.194	2.601	13.689	44.953
4	1.150	6.050	63.244	1.150	6.050	63.244	2.591	13.635	58.588
5	1.028	5.408	68.652	1.028	5.408	68.652	1.912	10.064	68.652

Table 11 shows that the strategies under the planning phase can be clustered into five main components. With the highest value of 39.33%, variables under Component 1 were highly correlated with tackling quality issues; hence, Component 1 was themed as **"Quality-related strategies"**. Component 2 was labelled as **"Business relationship-related strategies"** and Component 3 was labelled as **"Technical competencies-related strategies"**, since the associated variables can be linked to improving technical competencies. Next, Component 4 accounted for 6.05% of the total variance explained, and the variables can be intrinsically related to the theme of **"Design and procurement-related strategies"**. Lastly, based on their clear connection to improving productivity, Component 5 was unambiguously assigned the theme of **"Productivity-related strategies".**

Table 11: Rotated component matrix for strategies to minimise dispute during the planning phase

Strategies to minimise dispute during planning phase	Components				
	1	2	3	4	5
Execute proper risk allocation	.183	.205	-.001	.796	.095
Allocate adequate time to prepare for contract documentations	-.026	.217	.029	.679	.182
Establish an efficient communication system	.495	.212	.123	.431	.102
Early detection of problems	.594	.168	-.001	.522	.043
Provide timely resolution for problems	.414	.296	.197	.537	.025
Develop trust between parties	.161	.807	.100	.333	.089
Develop teamwork between parties	.350	.735	.094	.289	.161
Develop long-term relationship between parties	.257	.751	.162	.164	.101
Select an experienced contractor to undertake the project	-.036	.047	.885	.051	.119
Contractors should not take projects beyond their technical capabilities	.146	.089	.902	.023	.000
Clients should be punctual in giving instructions	.217	.127	.390	.383	.496
Consultants need to prepare clear and comprehensive documentation	.421	.058	.206	.465	.421
Select a professional construction team	.384	.209	.731	.115	.025
Quality control checks before issuance of documents	.669	.202	.310	-.016	.207
Proper record keeping	.824	.152	.053	.153	.032
Ensure full understanding of the contract requirements prior to signing the agreement	.667	.324	.111	.106	.303
Clients need to prepare an effective project planning	.129	.093	.202	.312	.664
Preserve a good relationship between the project team members	.135	.759	.080	.124	.490
Adopt digital technology to facilitate coordination and early detection of problems	.108	.280	-.130	-.022	.747
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalisation. a. Rotation converged in 7 iterations.					

Execution, Monitoring and Controlling Phase

Table 12 shows the three components that have emerged with eigenvalues of greater than 1.0.

Table 12: Total variance explained for strategies to minimise dispute during the execution, monitoring, and controlling phase

C	IE			ESSL			RSSL		
	T	% of Var	Cum %	T	% of Var	Cum %	T	% of Var	Cum %
1	5.452	49.566	49.566	5.452	49.566	49.566	2.862	26.016	26.016
2	1.270	11.548	61.114	1.270	11.548	61.114	2.696	24.513	50.529
3	1.023	9.303	70.417	1.023	9.303	70.417	2.188	19.888	70.417

The rotated component matrix, as shown in Table 13, illustrates the correlation between the variables and the components. Component 1 was themed as **"Business relationship-related strategies"**, while Component 2 was labelled as **"Productivity-related strategies"** because of their direct link to improving productivity issues. Finally, Component 3 was labelled as **"Payment-related strategies"**, since both variables were closely related towards resolving payment disputes.

Table 13: Rotated component matrix for strategies to minimise dispute during the execution, monitoring, and controlling phase

Strategies to minimise dispute during the execution, monitoring, and controlling phase	Components		
	1	**2**	**3**
Efficient communication	.623	.151	.465
Early detection of problems	.383	.692	.120
Provide timely resolution for problems	.615	.471	.199
Develop trust between parties	.858	.232	.064
Preserve a good relationship between the project team members	.857	.229	.142
Clients should avoid making unnecessary variations	.155	.739	.218
Clients should be punctual in giving instructions	.251	.763	.311
Proper record keeping	.537	.362	.301
Proper payment schedule	.190	.210	.914
Payment as and when due	.175	.193	.907
Adoption of digital technology to facilitate coordination and early detection of problems	.188	.726	.042
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalisation. a. Rotation converged in 4 iterations.			

Framework Development

The framework, built upon the substantiated and data-driven findings derived from the analysis of PCA results, offers a meticulously structured outline that encompasses both the identified causes and the strategic approaches relevant to each specific project phase (Refer to Figure 1). It is important to highlight that the results regarding the causes of disputes during the planning stage consistently align with the findings from a previous study. This earlier study suggests that the implementation of a rigorous tendering procedure is essential to foster ethical conduct among contractors (Ismail et al., 2017). Emphasising the significance of ethical conduct, especially during the planning stage and particularly within the tendering process, is crucial. Neglecting ethics in this context can lead to a decreased competitiveness in tendering, potentially leading to the selection of inappropriate contractors, and ultimately, adversely impacting the overall performance of the project.

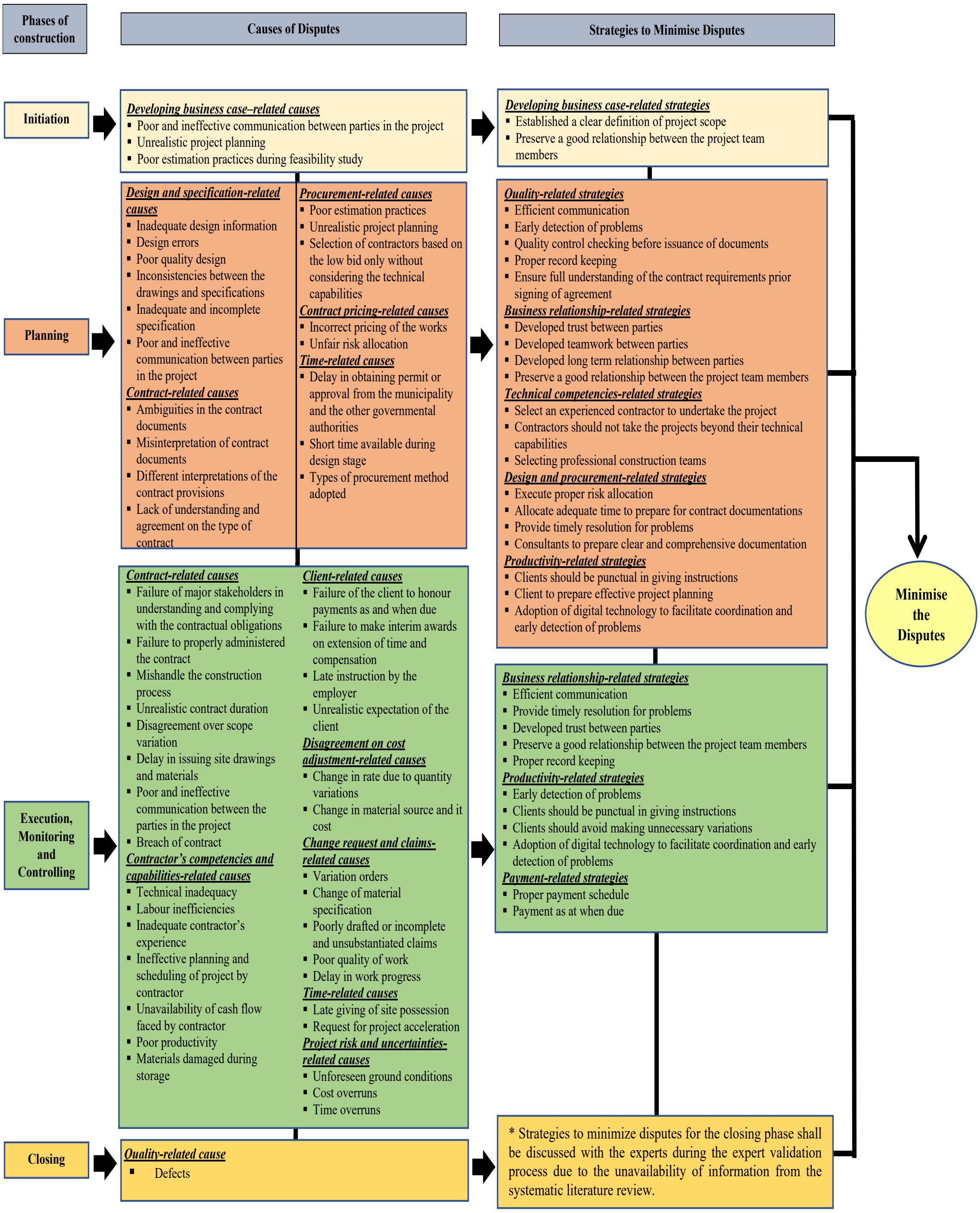


Figure 1: Preliminary framework to minimise the construction dispute in building projects

CONCLUSION

Overall, it is interesting to note that the PCA grouping has shown that the **"Contract-related causes"** and **"Time-related causes"** were nominated twice as the themes for causes of dispute, which indicated that these two groups can be deemed as the main contributory factors to dispute occurrences. These findings contributed to the knowledge area of project risk management, as disputes are considered as risks in a project that can influence its success rate. Despite facing several limitations, the findings of this study are expected to provide a general guideline for preventing dispute occurrences for construction practitioners. Furthermore, framework validation via expert validation could be done to further enhance the research findings, specifically to address the gaps in dealing with disputes during the closing phase which was not discovered during the SLR process.

ACKNOWLEDGEMENTS

The authors appreciatively acknowledge the grant provided by the Ministry of Higher Education Malaysia via the Fundamental Research Grant Scheme (FRGS/1/2019/SSI11/UM/02/3) (FRGS 2019-1).

REFERENCES

Adegbembo, T. F., Awodele, O., & Oke, A. (2020). A principal component analysis of knowledge management success factors in construction firms in Nigeria. *Journal of Construction Project Management and Innovation, 10*(1), 42-54.

Assaf, S., Hassanain, M.A., Abdallah, A., Sayed, A. M. Z., & Alsharani, A. (2019). Significant causes of claims and disputes in construction projects in Saudi Arabia. *Built Environment Project and Asset Management, 9*(5), 597-615.

Ayudhya, B. I. N. (2011). Common dispute related to public work projects in Thailand. *Songklanakarin Journal of Science and Technology*, *33*(5), 565-573.

Cakmak, E., & Cakmak, P. I. (2014). An analysis of causes of disputes in the construction industry using analytical network process. *Procedia-Social and Behavorial Sciences,* 109, 183-187.

Cohen, L., Manion, L., & Morrison, K. (2007). Research Methods in Education (6th ed.). Routledge Publishers, New York.

Dogbegah, R., Owusu-Manu, D, & Omoteso, K. (2011). A principal component analysis of project management competencies for the Ghanaian construction industry, *Australasian Journal of Construction Economics and Building,* 11(1), 26-40.

Elhag, T, Eapen, S., & Ballal, T. (2019). Moderating claims and disputes through collaborative procurement. *Construction Innovation, 20*(1), 79-96.

El-Sayegh, S., Ahmad, I., Aljanabi, M., Herzallah, R., Metry, S. & El-Ashwal, O. (2020). Construction disputes in the UAE: Causes and resolution methods. *Buildings,* 10(171), 1-14.

Field, A. (2005) Discovering Statistics Using SPSS, 2nd ed., Sage, London.

Hadi, N. U., Abdulah, N., & Sentosa, I. (2016). An easy approach to exploratory factor analysis: Marketing perspective. *Journal of Educational and Social Research,* 6(1), 215-223.

Ismail, F., Mohd Danuri, M.S., Mohamed, O., Abd-Karim, S.B. and Mohd Nawi, M.N. (2017). Ethics-Related Issues in the Tender Evaluation of Malaysia Public Projects. *Journal of Design and Built Environment*, Special Issue 2017.

Karji, A., Namian, M., & Tafazzoli, M. (2020). Identifying the key barriers to promote sustainable construction in the United States: A principal component analysis. *Sustainability,* 12, 1-20.

Kissi, E., Boateng, E. B., Adjei-Kumi, T., & Badu, E. (2017). Principal component analysis of challenges facing the implementation of value engineering in public projects in developing countries. *International Journal of Construction Management,* 17(2), 142-150.

Mahamid, I. (2016). Micro and macro level of dispute causes in residential building projects: Studies of Saudi Arabia. *Journal of King Saud University,* 28, 12-20.

Mohd-Nordin, R., Mohd-Ahnuar, E., Nasid-Masrom, M. A, Ameer-Ali, N. (2023). Examining Corruption Issues In Malaysia Construction Industry: Partaker Perspectives. *Planning Malaysia: Journal of the Malaysian Institute of Planners*, Vol. 21(2), 52-68.

Muhammuddin, N. N., Mohd-Danuri, M. S. and Hanid, M. (2022). Dispute Occurrences During Construction Stages of Building Project: A Systematic Literature Review, Journal of Project Management and Practice, Vol. 2(1), 1-19.

Mukilan, K., BalaNivetha, M., Velumani, P., & Christopher, G., S. (2019). A qualitative study and analysis of causes and disputes in claims in construction industry. *International Journal of Civil Engineering and Technology,* 10(1), 951-957.

Obeng-Ahenkora, N. K., & Danso, H. (2018). Principal component analysis of factors influencing pricing decisions of building materials in Ghana. *International Journal of Construction Management,* 1-9.

Omaraka, A. E. (2020). A principal component analysis of supply chain management skills for the Nigerian construction industry. *International Journal of Construction Management,* 1-10. Doi: 10.1080/15623599.2020.1797984

Pallant, J. (2013). SPSS Survival Manual. A step-by-step guide to data analysis using SPSS, 4th edition. Allen & Unwin. Retrieved from: www.allenandunwin.com/spss

PMI. Project Management Institute. (2017), *A guide to the project management body of knowledge PMBOK guide.* 6th ed. Newton Square, Pennsylvania: Project Management Institute, Inc.

Saar, C. C., Chuing, L. S., Hai, T. K., Yusof, A. M. (2017). Modelling dispute management in construction industry, *Malaysian Journal of Civil Engineering 29 Special Issue*, 1, 1-14.

Sakyiama, E. (2016). *Managing discords, disputes and conflicts in the Ghanaian construction industry: An empirical examination of traditional procurement of assembly projects*. [Master dissertation, University of Education, Winneba].

Soni, S., Pandey, M., & Agrawal, S. (2017). Conflicts and disputes in construction projects: An overview. *International Journal of Engineering Research and Application,* 7(6), 40-42. Treacy, D., Spillane, J. P., & Tansey, P. (2015).

Construction disputes in small to medium enterprises in Ireland during recession. *International Journal of Law in the Built Environment, 8*(1), 21-41.

Received: 7th June 2023. Accepted: 5th September 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 283 – 295

GREEN COVER TREND: TOWARDS A SUSTAINABLE CITY-CAMPUS RELATIONSHIP BETWEEN PUNCAK ALAM AND ITS VICINITY

Raziah Ahmad[1], Muhammad Adam Zakaria[2], Mohamed Ikhwan Nasir Mohamed Anuar[3], Zainuddin Ab Rahman[4], Jamalunlaili Abdullah[5]

[1234] Landscape Architecture Studies,
[5] Town and Regional Planning Studies,
School of Town Planning and Landscape Architecture,
College of Built Environment,
UNIVERSITI TEKNOLOGI MARA PUNCAK ALAM

Abstract

Urbanisation has emerged as a significant driver of global green cover changes. In response, cities and campuses increasingly recognise the importance of integrating nature into urban environments for sustainability. This study aims to investigate the temporal and spatial changes in green cover in Puncak Alam and its surroundings. This research involves examining land-use planning documents and satellite imagery data from 2016 to 2022. At the macro level, there was a significant loss of green cover from 2013 to 2016 (13.81%) due to urban expansion. From 2016 to 2022, the decrease in green cover was smaller (6.3%), followed by an expected increase of 3.2% in 2025. At the micro level, Puncak Alam experienced a significant decrease in green cover from 2016 to 2019 (4.8%), accompanied by an increase in man-made cover (3.5%). Collaborative efforts between cities and campuses are crucial for promoting green cover and creating environmentally resilient and socially vibrant urban areas.

[1] Senior lecturer at Universiti Teknologi MARA. Email: razia841@uitm.edu.my

INTRODUCTION

Rapid urbanization poses significant challenges for global urban resilience. Malaysia, as one of South East Asia's most urbanised nations, is projected to have an urban population of 22.58 million by 2025 (JPBD 2016; PLANMalaysia, 2016). Unfortunately, the conversion of green spaces, such as forests, parks, and agricultural land for profit-driven purposes has led to their decline (Kuala et al., 2004; Maryanti et al., 2016; Richards et al., 2017). This trend is particularly pronounced in several Southeast Asian cities, where green cover is alarmingly low.

The rapid urban expansion in Malaysia poses a threat to green cover, especially protected areas (Kanniah, 2017). Despite the declining per capita green space in Malaysian cities, urban green spaces are still being converted for purposes of housing, industry, and transportation infrastructure (Kanniah, 2017; Rasli et al., 2019). This trend contributes to climate-related environmental issues, including air pollution, rising temperatures, flooding, and landslides (Kanniah, 2017; Zaman et al., 2017; Morris et al., 2015; Elmahdy & Mostafa, 2013). However, it is crucial to recognize, preserve, and protect areas of green cover as they play a vital role in providing ecosystem services and enhancing the well-being of urban populations, helping to balance the ongoing growth of built-up areas.

To achieve enhanced sustainable development, Malaysian universities, under the encouragement of the Ministry of Higher Education, are actively implementing green campus projects and establishing Centers of Excellence (Muhiddin et al., 2023). As leading higher learning institutions, it is vital for universities to translate innovative theories and environmental education into tangible actions that promote sustainability and contribute to the shaping of a sustainable future for society. This study aims to investigate the potential of a city campus to become a significant green cover within a city, and to analyze green cover trends in Puncak Alam and its surrounding areas to foster a sustainable relationship between the campus and the city.

CAMPUS AS “GREEN COVER”

As demonstrated in this Land Use (LU) / Land Cover (LC) imagery study, the term "green cover" refers to vegetated areas in aerial data that are privately owned, shared, or publicly accessible for leisure and relaxation in urban settings (Kanniah, 2017). Studies conducted globally have highlighted the crucial role of green cover, including urban forests and parks, in climate change adaptation and mitigation (Selmi et al., 2016). It acts as a filter for polluted air, sequesters atmospheric $CO2$ (Tang et al., 2016), and aids in stormwater management (Berland et al., 2017). Even small city parks contribute to cooling effects that mitigate urban heat islands (Oliveira et al., 2014). Well-designed and well-maintained urban parks and recreational forests serve to foster social interaction, public health, and the overall well-being of urban dwellers (Donovan, 2017). Numerous studies conducted by Threlfall et al. (2017) and Karuppanan et al. (2014) reinforce the importance of urban green cover, particularly protected areas such as urban forests and parks.

Green cover in urban areas has garnered global attention due to its significant role in achieving United Nations Sustainable Development Goals (SDGs) and addressing urban climate change and population growth (Kanniah, 2017; "Millennium Development Goals Report 2014"). Universities recognize the importance of green cover for sustainability and can contribute by enhancing green spaces on their campuses and providing ecosystem services to surrounding areas. This aligns with SDG 15, which aims to protect forests, biodiversity, and promote sustainable management (Brandli et al., 2019). By having abundant green spaces, university campuses serve as vital partners in promoting sustainability and maximizing the use of green areas. By prioritizing local and regional sustainability initiatives, universities contribute to the integration of SDGs into green space planning, particularly SDG 4 for lifelong learning opportunities and SDG 15 for preserving natural resources for future generations. Education for sustainable development plays a crucial role in raising ecological awareness and fostering environmental conservation, and campus-city relationships encompass both physical and functional aspects of this (Curvelo Magdaniel et al., 2018).

The physical relationship between a campus and its surrounding city is referred to as the campus-city connection, which can be classified into three spatial configurations: outside the city, gated within the city, and integrated with the city (Mohammed et al., 2022). These spaces play a crucial role in promoting sustainability by influencing behaviour, disseminating values and information, and translating theoretical concepts into action (Finlay & Massey, 2012). Higher Education Institutions (HEIs) bear the responsibility of educating students and supporting sustainability initiatives within the academic community (Katiliate & Staniskis, 2017). When recognized for their ecological potential, university campuses can transform into green campuses, serving as educational and scientific hubs in addressing global challenges and seeking sustainable solutions (Thomashow, 2014). Acknowledging and harnessing the ecological potential of a university campus is the initial step towards practicing sustainability.

Maximising its green spaces enables university campuses to lead the way in sustainability, providing environmental, social, and economic benefits to densely populated surrounding areas (Brandli et al., 2019). However, neglecting the ecological potential of campuses jeopardises these advantages (Jennings et al., 2016). By expanding green cover and serving as green refuges, universities can foster the local spread of a culture of sustainability, benefiting the surrounding areas and increasing green cover per capita. Therefore, university campuses play a vital role in promoting a sustainable future and green potential.

METHODOLOGY

Located in Bandar Puncak Alam, Mukim Jeram, Kuala Selangor, the UiTM Puncak Alam Campus is affected by the changing landscape of its surrounding areas due to the development of new township. This has resulted in a significant decline in green cover within Puncak Alam. Furthermore, Selangor as a whole has experienced forest cover loss and agriculture cover loss since 2011 (Baig et al., Takaijudin, & Zeshan, 2022). This study focuses on Bandar Puncak Alam, specifically Mukim Ijok and Jeram, to examine the trend of green cover surrounding UiTM Puncak Alam, as shown in Figure 1. The analysis also includes the micro context of green cover trends within the UiTM Puncak Alam campus.

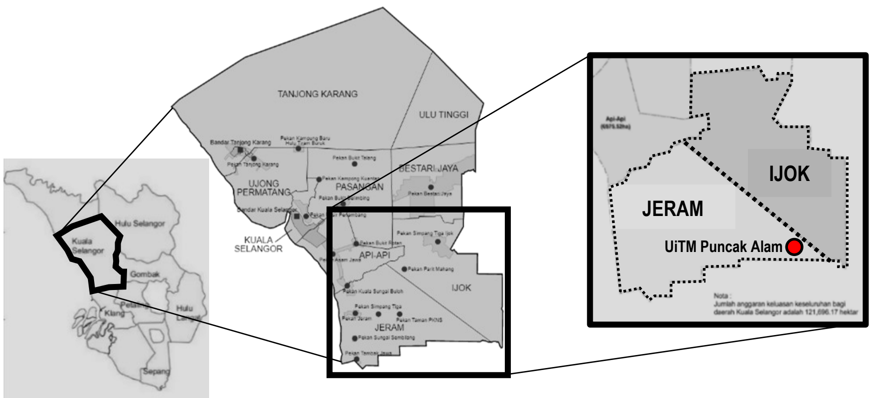


Figure 1 Location of Mukim Ijok and Jeram within Kuala Selangor district
Source: RT MDKS 2025

Data collection for analyzing land use and green cover distribution in Mukim Ijok and Jeram utilized a content analysis method and a geographic information system (GIS) mapping approach. Content analysis was carried out to analyze land cover distribution in 2013 and projected 2025 data from *Rancangan Tempatan Majlis Daerah Kuala Selangor 2025*, enabling flexible integration in spatial analysis (Zaleckis et al., 2019). GIS mapping using Open Street Map was employed to collect data on land use mapping and green cover distribution in 2016, 2019, and 2022. To ensure accuracy, this study adopted the Majlis Perbandaran Kuala Selangor's land use/land cover (LULC) classification for green cover (natural environment) and man-made cover (built environment) based on Kanniah's definition of green cover (2017), as presented in Table 1 below.

Table 1: Description of LULC in Mukim Ijok and Jeram

No	Land Use	2013		2025		Changes (Hectares)
		Area (hectares)	(%)	Area (hectares)	(%)	
Green cover						
1	Open space and recreation	502.35	1.8	534.74	1.9	32.39
2	Agriculture	20836.14	72.8	16015.27	55.9	-4820.87
3	Forest	73.83	0.3	65.55	0.2	-8.28
		21,412.31	74.9	16,615.56	58.0	(-16.9%)
Man-made cover						
4	Residential	1140.82	4.0	6094.66	21.3	4953.84
5	Industry	332.13	1.2	1871.41	6.5	1539.28
6	Commercial	88.41	0.3	434.38	1.5	345.97
7	Institution & Public Amenities	626.46	2.2	786.12	2.7	159.66
8	Infrastructure and Utilities	122.57	0.4	207.64	0.7	85.07
9	Transportation	2053.65	7.2	2314.5	8.1	260.85
10	Vacant Land	2542.2	8.9	60.16	0.2	-2482.04
		6906.24	24.2	11768.87	41	(+16.8%)
Excluded						
11	Waterbody	107.72	0.4	113.91	0.4	6.19
12	Coast/beach	199.03	0.7	127.82	0.4	-71.21
13	Aquaculture	14.69	0.1	13.84	0.0	-0.85
		321.44		255.57		
TOTAL		28640	100	28640	100	

Source: Analysed from RT MDKS 2025

This study examined land use and green cover changes in Mukim Ijok and Jeram, encompassing thirteen key land use and land cover (LULC) classes. LULC information was extracted from Open Street Map (OSM) data using visual interpretation and digital image processing techniques. Figure 2 illustrates the overall methodology employed in this study.

Extraction of study area administrative boundary

Extraction of the administrative boundary of the study area involved scanning and digitizing RTDKS 2023 topographical maps. Geo-referencing was performed in ArcGIS using affine transformation and nearest neighbourhood interpolation, with the datum set to WGS_1984 and projection set to UiTM. Sub-setting, mosaicking, and map digitization were conducted to extract the district boundaries within the study area.

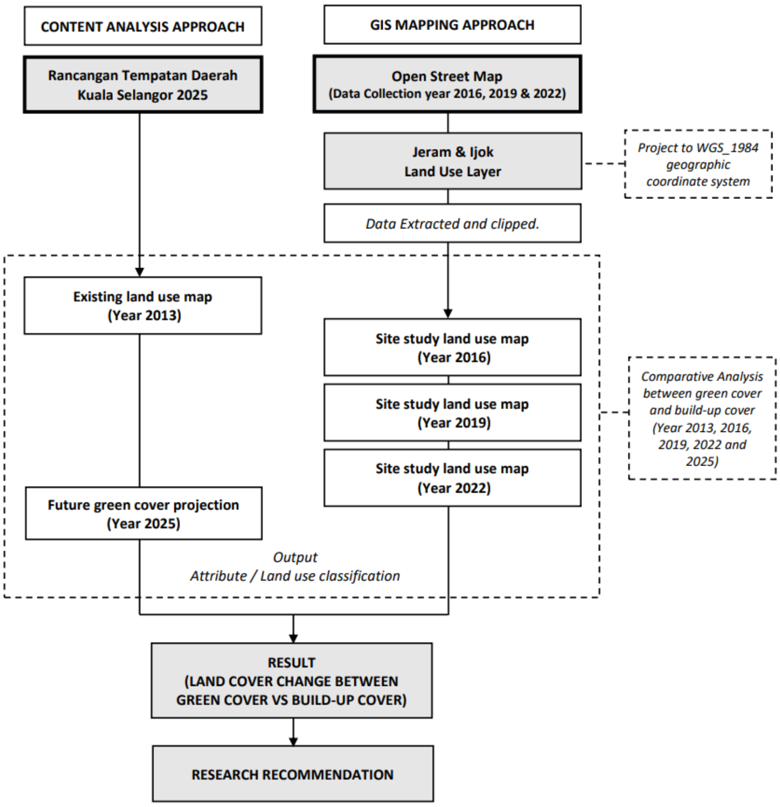


Figure 2: Research methodology flow chart
Source: Authors, 2023

OSM Data Preparation (OSM)

For the OSM data preparation, shape file maps of Malaysia for the years 2016, 2019, and 2022 were downloaded from Geofabrik's server (http://download.geofabrik.de/asia/malaysia-singapore-brunei.html). The extracted OSM layers were then clipped to the study area boundary. In ArcGIS software, two layers were visualized, including the boundary and land use. The reference vector data were initially projected in the WGS_1984 geographic coordinate system (Geofabrik, n.d.).

Change detection by Green cover area calculation

To detect changes in green cover, the agriculture and open land use areas were calculated for the years 2016, 2019, and 2022. The district-level change was observed by calculating the green cover area for Mukim Ijok and Jeram using the

Calculate Geometry tool. The loss of agriculture and open land between the specified consecutive time intervals was determined by comparing the classified shape files of the three consecutive years.

A comparative analysis was carried out to assess the green cover trends in Bandar Puncak Alam (Mukim Ijok and Jeram) from 2013 to 2022, along with the projected green cover for 2025. This analysis unveiled the overall land cover trend, focusing on the balance between green cover and man-made cover at the macro level in Bandar Puncak Alam. Additionally, it examined the green cover trend within the UiTM Puncak Alam campus at the micro level.

RESULTS AND DISCUSSION

This section explores the temporal and spatial changes in green cover through macro and micro analyses of green and man-made cover between 2013 and 2025. Table 2 presents the land cover data for Mukim Ijok and Mukim Jeram in 2013, along with the projected acreage for 2025. The analysis reveals a projected 17% decrease in green cover at the Mukim level by 2025, primarily attributed to urban expansion and the conversion of natural land into built environments.

Table 2: Total land cover in 2013 and the projected acreage in 2025

No	Land Use	2013 Area (hectares)	2013 (%)	2025 Area (hectares)	2025 (%)	Changes (Hectares)
Green cover						
	Total Green Cover	21,412.31	74.9	16,615.56	58.0	(-16.9%)
Man-made cover						
	Total Man-Made Cover	6906.24	24.2	11768.87	41	(+16.8%)
Excluded						
	Total excluded area (water bodies, beach, and aquaculture)	321.44		255.57		
TOTAL		28640	100	28640	100	

Source: Analysed from RT MDKS 2025

The projected 16.8% escalation in man-made cover in 2025 signifies the growth of Puncak Alam City and its growing population. This development has led to an increased demand for housing, infrastructure, and commercial projects, causing the loss of vegetation and green spaces (RT MDKS 2025). However, the information available in Table 2 from RT MDKS 2025 only provides land cover data for 2013 and projections for 2025, making it challenging to observe the trend of land cover changes over the 12-year period.

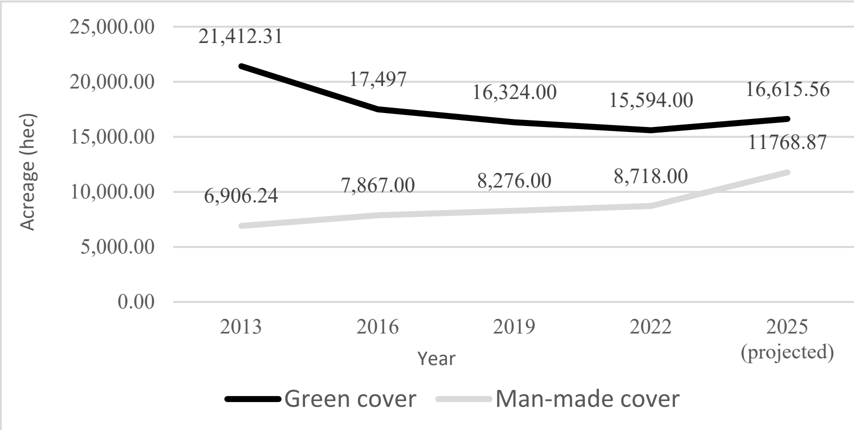


Figure 3: Trend of actual land cover changes between 2013-2022 and the projected trend in 2025 for Mukim Ijok and Mukim Jeram
Source: Analysed from GIS Open Data (https://download.geofabrik.de/)

The analysis of RT MDKS 2025 land cover data and GIS open data from 2013 to 2022 provides detailed insights into land cover changes. Figure 3 illustrates the changes from 2013 to 2022 and the projected change in 2025. A significant loss of green cover was experienced from 2013 to 2016 (13.81%), followed by a smaller decrease of 6.3% from 2016 to 2022, and an expected increase of 3.2% in 2025. The connection between gradual changes in green cover and development is evident, with urbanization and infrastructure expansion contributing to the gradual decline (Douglas, 2012). Recognizing this link has enabled decision-makers, urban planners, and developers to adopt sustainable practices that preserve green spaces, striking a balance between development and sustainability for resilient cities.

Figure 4 illustrates the spatial distribution of green land cover in Mukim Ijok and Mukim Jeram. Notable spatial patterns emerge in the distribution of green land cover between 2016 and 2022. Mukim Ijok has undergone significant changes in terms of man-made cover, particularly in the north, northwest, and southeast, including the Puncak Alam Town Centre. In contrast, Mukim Jeram, which houses UiTM Puncak Alam, shows fewer substantial changes in green cover compared to Mukim Ijok, which has been more impacted by the development of Puncak Alam Town.

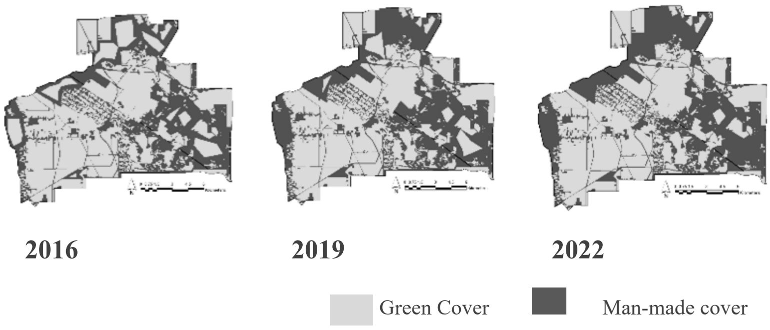


Figure 4: Spatial distribution of green and man-made covers between 2016-2022 of Mukim Ijok and Mukim Jeram
Source: Analysed from GIS Open Data (https://download.geofabrik.de/)

At the macro level, the RT MDKS 2025 categorizes UiTM Puncak Alam's land cover as institutional. However, when zooming in for a micro-scale perspective by analyzing land cover changes from 2016 to 2022 (Figure 5), insights emerge into temporal changes on this campus. Between 2016 and 2019, UiTM Puncak Alam witnessed a significant 4.8% reduction in green cover and a 3.5% increase in man-made cover, primarily due to the development of the UiTM Teaching Hospital. Moving forward from 2016 to 2022, a slight 0.8% decline in green cover and a 0.5% rise in man-made cover occurred.

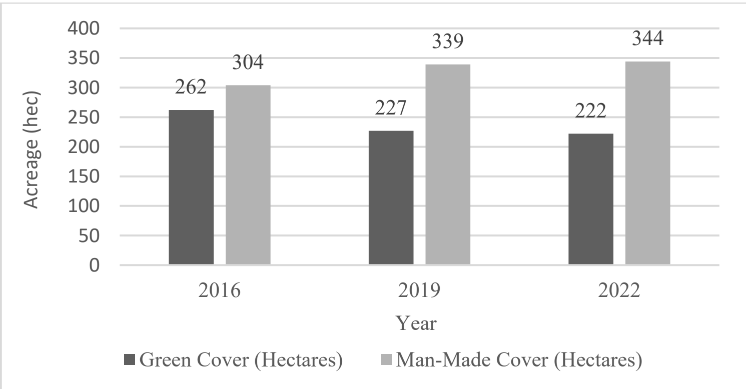


Figure 5: Temporal trend of land cover changes at UiTM Puncak Alam between 2016 to 2022
Source: Analysed from GIS Open Data (https://download.geofabrik.de/)

Figure 6 depicts that there are no significant spatial changes in green cover and man-made cover at UiTM Puncak Alam. However, it is projected that the rapid development of Puncak Alam City will impact the northern part of the campus. Moreover, the UiTM Hospital area in the north-eastern part is influenced by the nearby development of the Hill Park commercial area. Green cover in universities offers numerous benefits to the city, including environmental improvement, biodiversity support, human health promotion, educational and research opportunities, aesthetic enhancement, cultural value, and climate resilience. The establishment of the UiTM Green Centre (UGC) in 2020 further emphasized the integration of sustainability in education, community engagement, and knowledge transfer, underscoring the importance of incorporating green spaces in urban areas and fostering a sustainable city-campus relationship (UGC, 2022).

Figure 6: Spatial distribution of land cover changes in UiTM Puncak Alam Campus between 2016-2022
Source: Analysed from GIS Open Data (https://download.geofabrik.de/)

The changes in green cover in Mukim Jeram and Mukim Ijok from 2013 to 2025 highlight the significance of urban green cover in addressing environmental challenges that arise from rapid urbanization (Song et al., 2020). Monitoring and responding to these changes assist policymakers in implementing sustainable land management and enhancing resilience. Projections of land cover changes in 2025 play a crucial role in effective urban planning, infrastructure development, and the promotion of liveability. Incorporating these projections into decision-making empowers policymakers to advance environmental sustainability, identify suitable development areas, plan essential infrastructure, and create a future landscape that is both sustainable and resilient.

In summary, understanding and addressing temporal and spatial changes in land cover at both macro and micro scales highlight the importance of partnership between universities and cities in shaping societal and economic dynamics through the application of knowledge for urban and regional improvement (Mohammed et al., 2022).

CONCLUSION

The study reveals a 17% green cover reduction in Mukim areas by 2025 due to urban expansion and a 16.8% increase in man-made cover driven by Puncak Alam City's growth. Data limitations complicate tracking the 12-year trend, but examining 2013-2022 land cover data reveals fluctuations: a decline from 2013 to 2016, a lesser decrease from 2016 to 2022, and a projected 2025 increase. Recognizing the green cover-development link encourages sustainability, and this is further evident in the spatial changes in green land cover between 2016 and 2022 in Mukim Ijok and Mukim Jeram. The micro-scale analysis specifically emphasizes temporal changes at UiTM Puncak Alam, illustrating the positive impact of green spaces on cities, further supported by the sustainability efforts of the UiTM Green Centre. Monitoring green cover changes from 2013 to 2025 underscores urban green cover's role in addressing environmental challenges, guiding land management, and informing urban planning.

Continuous commitment and investment are necessary to enhance the green cover trend in city-campus sustainable relationships. Hence, future studies should consider sharing data surveys and focus group discussions with local authorities and experts. These methods enable comprehensive data collection, access to local expertise, data validation, collaboration, and co-creation of research. Engaging local authorities in the research process can generate more contextually relevant findings that can be helpful for future research and contribute to evidence-based decision-making.

In conclusion, land cover assessments highlight the vital university-city partnership, emphasizing green cover's urban importance and fostering sustainability collaborations. Universities may contribute to SDG 15 by promoting sustainability through green spaces and aligning with global sustainable goals.

ACKNOWLEDGEMENTS

The authors would like to express their gratitude for the financial support received from MyRA Grant, Universiti Teknologi MARA (Grant Number: 600-RMC/MyRA 5/3/LESTARI (055/2020)). This research forms part of the Socio-Ecological Urbanism project focused on resilience planning for the UiTM Puncak Alam Campus Landscape.

REFERENCES

Baig, M. F., Mustafa, M. R. U., Baig, I., binti Takaijudin, H., & Zeshan, M. T. (2022). Assessment of Land Uses Land Cover Changes and Future Predictions Using CA-ANN Simulation for Selangor, Malaysia. *Water*.

Berland, A., Shiflett, S., Shuster, W. D., Garmestani, A. S., Goddard, H. C., Herrmann, D. L., & Hopton, M. E. (2017). The role of trees in urban stormwater management. *Landscape and Urban Planning*, *162*, 167–177.

Brandli, L. L., Salvia, A. L., da Rocha, V. T., Mazutti, J., & Reginatto, G. (2019). The Role of Green Areas in University Campuses: Contribution to SDG 4 and SDG 15. *World Sustainability Series*.

Curvelo Magdaniel, F. (2017). *Campuses, Cities, and Innovation. 39 international cases accommodating tech-based research.*

Donovan, G. H. (2017). Including public-health benefits of trees in urban-forestry decision-making. *Urban Forestry \& Urban Greening*, *22*, 120–123.

Douglas, I. (2012). Urban ecology and urban ecosystems: Understanding the links to human health and well-being. *Current Opinion in Environmental Sustainability*, *pp. 4*, 385–392.

Elmahdy, S. I., & Mostafa, M. T. M. (2013). Natural hazards susceptibility mapping in Kuala Lumpur, Malaysia: an assessment using remote sensing and geographic information system (GIS). *Geomatics, Natural Hazards, and Risk*, *4*, 71–91.

Finlay, J. M., & Massey, J. (2012). Eco-campus: applying the ecocity model to develop green university and college campuses. *International Journal of Sustainability in Higher Education*, pp. *13*, 150–165.

GEOFABRIK *downloads* (n.d). OpenStreetMap Data Extracts. Retrieved May 20, 2023 from https://download.geofabrik.de/

Jennings, V., Larson, L. R., & Yun, J. (2016). Advancing Sustainability through Urban Green Space: Cultural Ecosystem Services, Equity, and Social Determinants of Health. *International Journal of Environmental Research and Public Health*, p. *13*.

Kanniah, K. D. (2017). Quantifying green cover change for sustainable urban planning: A case of Kuala Lumpur, Malaysia. *Urban Forestry \& Urban Greening*, *27*, 287–304.

Karuppannan, S., Baharuddin, Z. M., Sivam, A., & Daniels, C. B. (2013). Urban Green Space and Urban Biodiversity: Kuala Lumpur, Malaysia. *Journal of Sustainable Development*, *7*, 1.

Katiliūtė, E., & Stani\vskis, J. K. (2017). *Green Campus as an Integral Part of Sustainable University: Students' Perceptions*.

Kuala Lumpur City Hall. (2004). *Kuala Lumpur Structure Plan 2020*.

Kuala Selangor Municipal Council. (2013). *Rancangan Tempatan Majlis Daerah Kuala Selangor 2025*.

Maryanti, M., Khadijah, H., Uzair, A., & Ghazali, M. M. (2016). The Urban Green Space Provision Using The Standards Approach: Issues And Challenges Of Its Implementation In Malaysia. *Sustainable Development and Planning*, *210*, 369–379.

Millennium Development Goals Report (2014). (2014). *Midwifery*, *30 10*, 1043–1044.

Mohammed, A. M. S., Ukai, T., & Hall, M. (2022). Towards a sustainable campus-city relationship: A systematic review of the literature. *Regional Sustainability*.

Morris, K. I., Salleh, S. A., Chan, A., Ooi, M. C. G., Abakr, Y. A., Oozeer, M. Y., & Duda, M. G. (2015). Computational study of the urban heat island of Putrajaya, Malaysia. *Sustainable Cities and Society*, *19*, 359–372.

Muhiddin, A. M., Isa, H. M., Sakip, S. R. M., Nor, O. M., & Sedhu, D. S. (2023). GREEN CAMPUS IMPLEMENTATION IN THE MALAYSIAN PUBLIC UNIVERSITIES: CHALLENGES AND SOLUTIONS. *PLANNING MALAYSIA*.

Oliveira, S., Vaz, T., & Andrade, H. (2014). *Perception of thermal comfort by users of urban green areas in Lisbon*.

PLANMalaysia. (2016). *Dasar Perbandaran Negara Kedua: Semenanjung Malaysia & Wilayah Persekutuan Labuan (Second National Urbanization Policy)*. Retrieved from https://www.pmo.gov.my/dokumenattached/Dasar/Dasar-Perbandaran-Negara-Kedua.pdf

Rasli, F. N., Kanniah, K. D., & Ho, C. S. (2019). Analysis of Fragmented Green Spaces in Kuala Lumpur, Malaysia. *Chemical Engineering Transactions*, *72*, 457–462.

Richards, D. R., Passy, P., & Oh, R. R. Y. (2017). Impacts of population density and Wealth on the Quantity and Structure of urban green space in Tropical Southeast Asia. *Landscape and Urban Planning*, pp. *157*, 553–560.

Selmi, W., Weber, C., Rivière, E. D., Blond, N., Mehdi, L., & Nowak, D. J. (2016). Air pollution removal by trees in public green spaces in Strasbourg city, France. *Urban Forestry \& Urban Greening*, *17*, 192–201.

Song, Y., Chen, B., & Kwan, M. (2020). How does urban expansion impact people's exposure to green environments? A comparative study of 290 Chinese cities. *Journal of Cleaner Production*, *246*, 119018.

Tang, Y., Chen, A., & Zhao, S. (2016). Carbon Storage and Sequestration of Urban Street Trees in Beijing, China. *Frontiers in Ecology and Evolution*, p. *4*.

Thomashow, M. S. (2014). *The Nine Elements of a Sustainable Campus*.

Threlfall, C. G., Mata, L., Mackie, J. A., Hahs, A. K., Stork, N. E., Williams, N. S. G., & Livesley, S. J. (2017). Increasing biodiversity in urban green spaces through simple vegetation interventions. *Journal of Applied Ecology*, *54*, 1874–1883.

UiTM Green Centre. (n.d.). *About UGC*. Retrieved from https://ugc.uitm.edu.my/index.php/about-ugc

Zaleckis, K., Vileniske, I. G., Vitkuvienė, J., Tranavi\vciūtė, B., Doğan, H. A., Sinkienė, J., & Grunskis, T. (2019). Integrating Content Analysis Into Urban Research: Compatibility With Sociotope Method and Multimodal Graph. *SAGE Open*, *9*.

Zaman, N. A. F. K., Kanniah, K. D., & Kaskaoutis, D. G. (2017). Estimating Particulate Matter using satellite-based aerosol optical depth and meteorological variables in Malaysia. *Atmospheric Research*, *193*, 142–162.

Received: 24th July 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 296 – 308

COMMUNITY KNOWLEDGE AND PERCEPTIONS TOWARDS ILLEGAL WASTE DISPOSAL: A CASE STUDY OF SUNGAI BESAR COASTLINE MANGROVES FOREST IN SELANGOR, MALAYSIA

Imroatu Soleheh Suandi[1], Mohamad Faiz Zainuddin[1,2], Latifah Abdul Manaf[1], Faridzah Jamaluddin[3], Siti Munirah Mohd[4]

[1]*Faculty of Forestry and Environmental,*
UNIVERSITI PUTRA MALAYSIA
[2]*Institute for Mathematical Research (INSPEM),*
UNIVERSITI PUTRA MALAYSIA
[3]*Planning & Research Division,*
INSTITUTE FOR YOUTH RESEARCH MALAYSIA
[4]*GENIUS Insan College,*
UNIVERSITI SAINS ISLAM MALAYSIA

Abstract

Mangroves around the world are under constant threat from household waste pollution. Illegal landfills were found at the Sungai Besar coastline mangrove forests near Kampung Baru Nelayan, Selangor, Malaysia. Therefore, this study aims to gauge residents' level of knowledge and perceptions on illegal waste disposal in mangrove forests. A total of 304 respondents participated in this study. The data were analysed using descriptive statistics, non-parametric methods, and linear regression. The mean knowledge score was 0.70 ± 0.09 (range: 0-1), and the mean score for perception was 4.57 ± 0.47 (range: 1-5). Further analysis revealed that occupation played a significant role in determining measured knowledge and perception among the respondents (p-value < 0.01). Government employees were found to have higher knowledge and perception scores than unemployed residents. Targeted environmental education and conservation programs directed towards unemployed residents are recommended to increase their knowledge and perception of illegal waste disposal in mangrove forests.

Keywords: Illegal landfill, illegal waste disposal mangrove forest, knowledge, perception

[2] Lecturer at Universiti Putra Malaysia. Email: z_faiz@upm.edu.my

INTRODUCTION

Mangrove habitats cover approximately 135,881 km^2 of land area, accounting for about 11.96% of the world's coastline (Bir, 2022). Mangroves provide critical services to the coastal communities such as coastal protection from erosion and serving as breeding grounds for fishes (Mat Yamin, 2019). However, mangrove ecosystems around the world face several threats such as deforestation, land conversion, unsustainable urban development, polluted water, and improper waste management (Abd Rahman & Asmawi, 2016, Friess et al., 2019; Mazelan & Yusuff, 2021).

Illegal dumpsites can be found along the Sungai Besar mangrove coastline forest near Kampung Baru Nelayan, a small village located in the district of Sabak Bernam, Selangor, Malaysia (Figure 1). Broken furniture, damaged electronic devices, porcelain, plastic bags and containers, toys, and books are among the household wastes discovered at these sites. Lack of knowledge and awareness are often cited as reasons for poor waste management attitudes and practices (Ahmad et al., 2019; Aziz, 2021; Hassan & Rosli, 2022). On the other hand, Sattayapanich et al. (2022) discovered that perceived ecological values were the strongest predictor of community participation in corporate social responsibility (CSR) mangrove forest management programs, which include planning, implementation, and monitoring.

Therefore, this study aims to assess the levels of knowledge and perception on illegal waste disposal at mangrove forests among residents of Kampung Baru Nelayan. Specifically, the present study seeks to (1) investigate the differences in mean knowledge and perception scores across demographic characteristics, (2) identify factors related to knowledge and perception scores, and (3) examine the relationship between knowledge and perception scores. Findings from this research will be compared with those from similar studies involving communities who live nearby mangrove forests.

Figure 1: Illegal dumpsite at the mangrove forest near Kampung Baru Nelayan
Source: own field observation.

RESEARCH METHODOLOGY

Study location

Kampung Baru Nelayan is located next to Sungai Besar town in the Sabak Bernam district of Selangor, Malaysia (Figure 2). This location was chosen for the study because it is the nearest community to the sites of illegal waste disposal and the mangrove forest. The sites of illegal waste disposal can be found along a small road (red oval) that connects Sungai Besar to nearby villages, residential areas, and aquaculture farms.

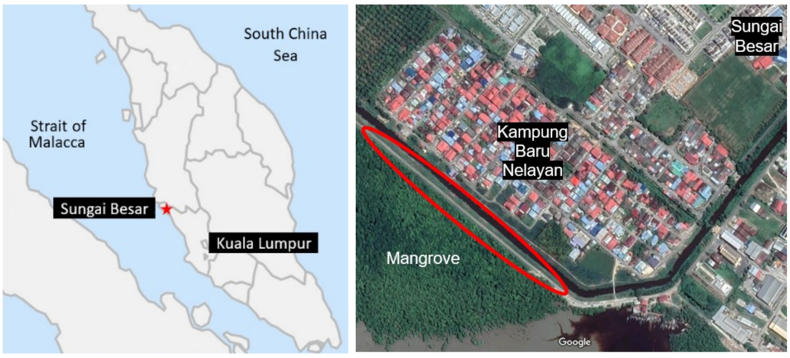


Figure 2: (Left) The location of Sungai Besar in peninsular Malaysia. (Right) Satellite image of Kampung Baru Nelayan and the nearest mangrove forest
Source: MapChart and Google Map.

Sample Size

According to Pusat Digital Ekonomi Kampung Baru Nelayan, the community has a population of 1,450. The required representative sample size needed to achieve the objective of this study with sufficient statistical power was calculated using the Corrected Cochran's Formula, resulting in 304 respondents with a 95% confidence level.

Research Design

The questionnaire was divided into three sections. The first section gathered demographic information from respondents, namely gender, educational level, age, and occupation type. Gender was coded as 1 for women (reference category), and 0 for men. Education was categorized as UPSR (reference category), PMR/SPM, STPM/diploma, and university degrees. Age was categorized as 18-27 (reference category), 28-37, 38-47, 48-57, and ≥ 58. Occupation type was broken down into unemployed (reference category), government, private, housewife, self-employed, and others. 'Others' refers to respondents who do not belong to any other category, including students who are either already enrolled in a university or waiting to be enrolled.

The second section assessed respondents' level of knowledge (K) with eleven items. Responses were recorded on a binary scale with either "Yes" or "No" as the answer. The third section assessed respondents' level of perceptions (P) with ten items. Responses were recorded on a Likert scale ranging from 1 to 5 (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree). All items in the questionnaire were validated by four experts in environmental studies. The reliability of the questionnaire was tested with 30 respondents in a pilot study.

Data Collection

This survey was conducted among the residents of Kampung Baru Nelayan from November 2021 to December 2021 using a random sampling method. Due to the restricted movement and lockdowns resulting from the COVID19 pandemic, data was collected online through a self-reported questionnaire administered via Google Forms. Given the high internet usage among residents at Kampung Baru Nelayan, a link to the survey was distributed to residents via WhatsApp groups. The questionnaire was administrated in both English and Bahasa Melayu.

Statistical Analysis

This study utilized descriptive and non-parametric data analyses. Linear regression was conducted to identify factors related to knowledge and perception scores, as well as the relationship between knowledge and perception scores. All analyses were conducted using IBM SPSS Statistics 26 Software.

RESULTS

Demographic Characteristics

Table 1 presents the demographic characteristics of the respondents. Out of all respondents, 159 (52.3%) were women, while 145 (47.7%) were men. In terms of age, the majority of respondents fell within the 18-27 age group (37.8%). In terms of education, most of the respondents possessed an STPM certificate or diploma. Regarding occupation type, 112 (36.8%) of the respondents identified themselves as self-employed, while only 21 (6.9%) identified as unemployed.

Assessment of Knowledge and Perception

Tables 2 and 3 present the responses to the survey questions. Most of the respondents demonstrated a strong understanding of illegal waste disposal (K1, K2), legal implications (K3), and negative impacts of illegal waste disposal on mangrove forests and human health (K5-K11). Interestingly, close to two-thirds of the respondents (61.8%) believe that illegal dumping activities at mangrove forest reserves can be controlled and avoided (K4). In terms of perception, a vast

Table 1: Respondent's Background in Kampung Baru Nelayan (N = 304)

Variable	Description	Frequency (N)	Percentage (%)
Gender	Male (ref)	145	47.7
	Female	159	52.3
Education	UPSR (ref)	42	13.8
	PMR/SPM	103	33.9
	STPM/Diploma	113	37.2
	Universiti degree	46	15.1
Age	18-27 (ref)	115	37.8
	28-37	73	24.0
	38-47	23	7.6
	48-57	68	22.4
	58 and above	25	8.2
Employment type	Government	60	19.7
	Private	18	5.9
	Housewife	61	20.1
	Self-employed	112	36.8
	Unemployed (ref)	21	6.9
	Others	32	10.5

Table 2: Responses to the questionnaire on illegal waste disposal knowledge

Statement	Frequency (percentage)	
	Yes	No
Illegal dumping is waste dumped onto public land where there is no approval license.	303 (99.7%)	1 (0.3%)
Improper waste management does not cause illegal dumping.	54 (17.8%)	250 (82.2%)
Illegal dumping of waste can lead to imprisonment not exceeding 5 years or a fine not exceeding RM500,000.	302 (99.3%)	2 (0.7%)
Illegal dumping activities at forest reserves are uncontrollable and unpreventable.	116 (38.2%)	188 (61.8%)
Illegal dumping activities have a positive impact on the environment.	32 (10.5%)	272 (89.5%)
Illegal dumping activities do not affect humans.	24 (7.9%)	280 (92.1%)
Illegal dumping can cause water pollution.	300 (98.7%)	4 (1.3%)
Illegal dumping areas can lead to Aedes breeds.	302 (99.3%)	2 (0.7%)
Illegal dumping activities can attract pests such as rats and cockroaches.	304 (100%)	-
Open burning can occur at illegal dumping areas.	301 (99.0%)	3 (1.0%)
Illegal dumping areas can cause a bad odour.	304 (100%)	-

Table 3: Responses to perception statements regarding illegal waste disposal

Statement	Frequency (percentage)				
	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
Illegal dumping can occur everywhere.	7 (2.3%)	1 (0.3%)	5 (1.6%)	68 (22.4%)	223 (73.4%)
Illegal dumping is the wrong action.	4 (1.3%)	-	2 (0.7%)	60 (19.7%)	238 (78.3%)
Maintaining the sustainability of forest reserves from illegal dumping activities is not a priority.	177 (58.2%)	75 (24.7%)	28 (9.2%)	7 (2.3%)	17 (5.6%)
Effective waste collection services can prevent illegal dumping.	1 (0.3%)	4 (1.3%)	5 (1.6%)	100 (32.9%)	194 (63.8%)
Reducing illegal dumping activities can preserve ecosystems at forest reserves.	3 (1.0%)	1 (0.3%)	4 (1.3%)	94 (30.9%)	202 (66.4%)
Water quality can be affected in illegal dumping areas.	3 (1.0%)	2 (0.7%)	4 (1.3%)	78 (25.7%)	217 (71.4%)
Open burning may occur in illegal dumping areas which can affect air quality.	5 (1.6%)	1 (0.3%)	5 (1.6%)	89 (29.3%)	204 (67.1%)
Illegal dumping areas contribute to the increase in dengue cases.	2 (0.7%)	1 (0.3%)	5 (1.6%)	102 (33.6%)	194 (63.8%)
Wild animals such as wild dogs at illegal dumping areas do not disturb the peace of the surrounding residents.	216 (71.1%)	56 (18.4%)	9 (3.0%)	4 (1.3%)	19 (6.3%)
The residents' health is not affected by illegal dumping activities.	184 (60.5%)	95 (31.3%)	13 (4.3%)	3 (1.0%)	9 (3.0%)

Majority of respondents have a favourable perception regarding negative aspects of illegal waste disposal activities (P1-P5) and the associated risks (P6-P10). The mean knowledge score was 0.70 ± 0.09, indicating a high level of knowledge according to the Bryman and Cramer (2005) classification. The accuracy rate for the knowledge test was 92.81% (10.21/11 × 100). The mean perception score was 4.57 ± 0.47, indicating a good level of perception.

Non-parametric Analysis

Univariate statistics was conducted to determine differences in knowledge and perception scores among demographic characteristics (Table 4). The results reveal that there are no significant differences (p-value > 0.05) based on gender, education level, and age. The only demographic characteristic showing a significant difference (p-value < 0.05) is occupation. Based on mean ranks, it can be observed that those who work in the government sector achieved the highest knowledge score (mean rank = 175.30), while those who are unemployed achieved the lowest score for knowledge (mean rank = 98.19). On the other hand, those who identified themselves as "others" attained the highest score for perception (mean rank = 179.75), while those who are unemployed received the lowest score for perception (mean rank = 79.62).

Table 4: Respondent's Background in Kampung Baru Nelayan (N = 304)

Variable	Description	Knowledge score		Perception score	
		Mean Rank	***p-value***	**Mean Rank**	***p-value***
Gender	Male (ref)	144.72	0.107	147.94	0.384
	Female	159.60		156.66	
Education	UPSR (ref)	153.70	< 0.1	135.21	0.218
	PMR/SPM	140.57		148.98	
	STPM/Diploma	166.88		165.01	
	Universiti degree	142.77		145.43	
Age	18-27 (ref)	148.33	0.296	152.90	0.311
	28-37	158.99		168.44	
	38-47	125.22		130.67	
	48-57	163.86		147.33	
	58 and above	146.94		138.26	
Employment type	Government	175.30	<0.01	160.46	< 0.01
	Private	154.47		153.72	
	Housewife	156.48		152.57	
	Self-employed	144.07		153.88	
	Unemployed (ref)	98.19		79.62	
	Others	166.20		179.75	

Regression Analysis

In addition to descriptive and non-parametric analyses, regression analysis was conducted to explore the relationship between each demographic characteristic and their respective reference categories, as previously mentioned in the research design (Table 5). The results suggest that there are no statistically significant differences between males and females, primary education level and the other levels of education, and the age group of 18-27 and the other age groups, in terms of both measured knowledge and perception.

However, there are some inconsistencies for occupational type. In terms of knowledge, being unemployed is found to be significantly different than government sector, housewives, and others; but not statistically different from the private sector and the self-employed. On the other hand, in terms of perception, being unemployed shows a significant difference compared to all the other occupation types. Furthermore, measured knowledge is found to be significantly different than measured perception (p-value < 0.0001). Regarding the Pearson correlation (R = 0.350), the relationship between knowledge and perception is considered statistically moderate (R = 0.30 – 0.49) according to the classification by Cohen (1988). The relationship is positive, as indicated by a positive value of coefficient *b*.

Table 5: Regression analysis

Knowledge and perception-related factors						
Variables	**Knowledge score**			**Perception score**		
	β	**SE**	***p-value***	***β***	**SE**	***p-value***
Gender						
Female	0.211	0.119	0.078	-0.084	0.537	0.876
Educational level						
PMR/SPM	-0.156	0.190	0.413	0.614	0.849	0.470
STPM/Diploma	0.157	0.188	0.402	0.714	0.838	0.395
University degree	-0.040	0.222	0.856	-1.357	0.989	0.171
Age						
28-37	0.154	0.156	0.324	0.1013	0.701	0.149
38-47	-0.278	0.237	0.242	-0.043	1.069	0.968
48-57	0.235	0.159	0.141	0.416	0.716	0.562
58 and above	-0.028	0.229	0.904	0.379	1.033	0.714
Employment type						
Government	0.800	0.261	0.002	6.750	1.105	<0.0001
Private	0.500	0.330	0.131	5.611	1.399	<0.0001
Housewife	0.678	0.260	0.010	6.716	1.102	<0.0001
Self-employed	0.414	0.245	0.092	6.693	1.036	<0.0001
Others	0.677	0.289	0.020	7.729	1.223	<0.0001
The relationship between knowledge and perception						
	R	**R^2**	***β***	**SE**	***t-stat***	***p-value***
Knowledge	0.350	0.123	1.569	0.241	6.499	<0.0001

DISCUSSION

Knowledge and Perception on Mangrove Forest Sustainability

The findings from this study suggest that, in general, the community of Kampung Baru Nelayan possesses a strong knowledge and perception regarding illegal waste disposal and its impact on mangrove forests. For comparison, a recent survey by Mazelan and Yusuff (2021) found that residents of Kuala Selangor exhibited a high level of knowledge (n = 256, accuracy rate = 85.3%) and awareness (n = 256, mean score = 4.48) concerning the impact of domestic waste disposal on the sustainability of mangrove forests. Similarly, Abdullah et al. (2021) identified a high level of knowledge (n = 100, total score = 80.93±7.77) on the importance and sustainability of mangrove forests among respondents who lived within the vicinity of Sijangkang Mangrove Recreational Park in Kuala Langat district, as determined through in-depth interviews.

The findings from this study, along with those of Mazelan and Yusuff (2021) and Abdullah et al. (2021) suggest that communities who live or reside near mangrove forests in the state of Selangor are knowledgeable about the importance of mangrove forest sustainability and conservation, and environmental issues associated with mangrove forests such as plastic pollution, illegal waste disposal, and littering. This positive outcome may be as a result of years of environmental awareness campaigns aimed towards residents of Selangor conducted by various governmental agencies and non-profit organizations such as the Department of Environment (DOE), Selangor Forestry Department, state municipal councils, Malaysia Nature Society (MNS), and Friends of Mangrove. According to Sharma et al. (2023), environmental education is considered as one of the best approaches to solve environmental degradation issues caused by anthropogenic activities. Environmental education is essential for fostering fundamental shifts in how people think, act, and make better decisions for the environment.

The Influence of Occupation on Knowledge and Perception

Abdullah et al. (2021) examined the relationship between the level of knowledge and demographic factors. Through ANOVA analysis, Abdullah et al. (2021) determined that there are no significant differences in knowledge scores between gender, race, income, work sector (occupation), and residency. Instead, significant differences in knowledge scores were only observed for education level. Interestingly, this contradicts the findings of the current study, This finding was contrary to what was found in this study, which determined that no significant differences in knowledge scores existed based on education levels. Instead, significant differences were identified between occupation groups (Table 5).

As discussed previously, respondents in the government sector attained the highest score for knowledge and second highest score for perception (Table 5). This finding was in line with observations reported in Pour et al. (2023), who discovered that government servants (n = 21) tend to appreciate forest ecosystem services (FES) more than other sectors based on a study conducted at the Hara Biosphere Reserve mangrove forest in the Persian Gulf. Specifically, this study also highlighted that government servants value mangrove forests as a solution to natural hazard mitigation (score = 90.5%). Furthermore, Pour et al. (2023) showed that there were significant variations in perceptions of mangrove forest services across different occupations.

Pour et al. (2023) concluded by stating that locally adjusted education and conservation programs should be developed based on the perceptions of the locals towards mangrove forests. This suggestion could be applied to the Sungai Besar mangrove forest and Kampung Baru Nelayan community as well. As evidenced in Table 5, it is apparent that there were significant variations in perceptions on the negative impacts of illegal waste disposal on mangrove forests across different occupations. Therefore, targeted education and conservation programs, especially for the unemployed members of the community, are recommended to improve their knowledge and perception.

The Association between Knowledge and Perception

In general, knowledge has a positive impact on human attitudes, willingness, perceptions, and practices within forest management and sustainability (Min et al., 2018; Gebregziabher & Soltani, 2019; Liu, 2020; Lucungu et al., 2022; Pour et al., 2023). As demonstrated in this study, the regression analysis indicated a significant and a positive yet weak correlation between respondents' knowledge of illegal waste disposal and their perceptions towards illegal waste disposal in mangrove forests. This generally followed similar trends established in prior studies. In terms of occupation, government employees, housewives, self-employed, and "others" who received high scores for knowledge also received high scores for perception. Similarly, unemployed respondents who received low scores for knowledge also received low scores for perception.

Recommendations from other studies

As stated earlier, this study recommends the implementation of targeted education and conservation programs for unemployed members of the community, to improve their knowledge and perception on illegal waste disposal and its impact on mangrove forests. However, past studies on mangrove forest conservation show that attention and involvement from other segments of society are equally important for effective preservation methods. For example, Kusin et al. (2019) states the importance of active participation from minority groups of the local communities, younger generations, and education institutions in the conservation and management of river and mangrove ecosystems in Kong Kong Laut, Johor, Malaysia. On the other hand, Sunoto et al. (2020) stated the need for the authorities to engage a broader range of communities near mangrove forests instead of only relying on fisherman, as demonstrated in their study in Kampung Sungai Melayu, Johor, Malaysia. In view of urban and regional planning, these recommendations highlight the challenges faced by authorities in designing and implementing successful mangrove forest management and conservation programs with significant contributions from communities and stakeholders. For this, authorities must device strategic plans to increase environmental awareness of this issue among the society and local communities, and to encourage them to actively take part in preserving mangrove forests.

Limitations of the study

The scope of this study is limited to assessing the levels of knowledge and perception on illegal waste disposal at mangrove forests among the residents of Kampung Baru Nelayan. However, this study does not examine the causes of illegal landfills at the mangrove forests. Furthermore, this study does not examine the level of attitude and practice of the local community towards illegal landfill. Further research is needed to highlight these issues.

CONCLUSION

This study has successfully assessed the level of knowledge and perception regarding illegal waste disposal in mangrove forests among the residents of Kampung Baru Nelayan. In general, the respondents exhibit a good level of knowledge of the negative consequences of illegal waste disposal on the environment and human health. They also demonstrate a good perception on the importance of sustaining and preserving mangrove forests by reducing illegal waste activities at the forests. The knowledge and perception scores among the respondents vary significantly among different occupational groups. Government employees, housewives, self-employed, and "others" achieved high scores for both knowledge and perception, while unemployed respondents obtained the lowest scores for both knowledge and perception.

Based on these findings, targeted education and conservation programs, especially for the unemployed members of the community, are recommended to improve their knowledge and perception on illegal waste disposal at mangrove forests. Authorities and program coordinators are advised to plan and design their mangrove forest education and conservation programs carefully, with effective communication tools and comprehensive outreach efforts to address challenges faced by the community near mangrove forests. This is essential to improve their understanding on mangrove forest sustainability and management.

REFERENCES

Abd Rahman, M. A. & Asmawi, M. Z. (2016). Mangroves Degradation: A Local Perspective on Its Awareness. *Journal of the Malaysian Institute of Planners*, Special Issue IV, 251 – 262. https://doi.org/10.21837/pm.v14i4.162

Abdullah, R., Hanif, A. F., Toufik, S., Zakaria, R. M., Kadir, W. R., Husin, T. M., Halim, N. S. and Ajeng, A. A. (2021). Community Knowledge, Attitude, and Practice towards Importance and Sustainability of Mangrove Forests: A Case Study of Kuala Langat, Malaysia. *International Journal of Research and Innovation in Social Science*. 5(5), 222-235. https://doi.org/10.47772/IJRISS.2021.5511

Ahmad, I., Chelliapan, S., Abdullah, N., & Ahmad, M. D. (2019). Sanitary Landfill is a Solution in Solid Waste Management or a Silent Threat to Environment: Malaysian Scenario. *Open International Journal of Informatics*, 7, 135–146.

Aziz, A. (2021, March 3). Lack of knowledge, tech, finance hinder sustainable waste management. *The Malaysian Reserve*. https://themalaysianreserve.com/2021/03/23/lack-of-knowledge-tech-finance-hinder-sustainable-waste-management

Bir, B. (2022, July 26). Mangroves, world's unique ecosystems, declining at alarming level. *Anadolu Agency*. https://www.aa.com.tr/en/environment/mangroves-worlds-unique-ecosystems-declining-at-alarming-level/2645842

Friess, D. A., Rogers, K., Lovelock, C. E., Krauss, K. W., Hamilton, S. E., Lee, S. Y., Lucas, R., Primavera, J., Rajkaran, A. & Shi. S. (2019). The State of the World's Mangrove Forests: Past, Present, and Future. *Annual Review of Environment and Resources*, 44(1), 89-115. https://doi.org/10.1146/annurev-environ-101718-033302

Gebregziabher, D. & Soltani, A. (2019). Exclosures in people's minds: perceptions and attitudes in the Tigray region, Ethiopia. *Forest Policy and Economy*, 101, 1–14. https://doi.org/10.1016/j.forpol.2019.01.012

Hassan, N. & Rosli, N. S. (2022). Knowledge, Attitude and Practice on Waste Management among University Students in Malaysia. *Malaysian Journal of Tropical Geography*, 2022, 48(2), 1-15. https://doi.org/10.1007/978-981-16-7920-9_13

Kusin, F. M., Joni, A. A. M., Yusuff, F. M. & Hasan, S. N. M. S. (2019). Evaluating Capacity Building of the Local Community towards Environmental Conservation in an Estuarine Community, Kong Kong Laut, Johor. *Journal of the Malaysian Institute of Planners*, 17(2), 101 – 111. https://doi.org/10.21837/pm.v17i10.632

Liu, Y., 2020. The willingness to pay for ecosystem services on the Tibetan plateau of China. *Geography and Sustainability*, 1(2), 141–151. https://doi.org/10.1016/j.geosus.2020.06.001

Lucungu, P.B., Dhital, N., Asselin, H., Kibambe, J.-P., Ngabinzeke, J.S. & Khasa, D.P. (2022). Local perception and attitude toward community forest concessions in the democratic republic of Congo. *Forest Policy & Economy*, 139, 102734. https://doi.org/10.1016/j.forpol.2022.102734

Mat Yamin, R. A. (2019, February 13). Mangrove ecosystem's importance not understood. *The Straits Times*. https://www.nst.com.my/opinion/columnists/2019/02/459981/mangrove-ecosystems-importance-not-understood

Mazelan, N. A. & Yusuff, F. M. (2021). Community Awareness on Domestic Waste Disposal Towards Its Impact to the Sustainability of Mangrove Forest in Kuala Selangor. *IOP Conference Series: Earth and Environmental Science*, 943, 1-11. https://doi.org/10.1088/1755-1315/934/1/012050

Min, S., Bai, J., Huang, J. & Waibel, H. (2018). Willingness of smallholder rubber farmers to participate in ecosystem protection: effects of household wealth and environmental awareness. *Forest Policy & Economy*. 87, 70–84. https://doi.org/10.1016/j.forpol.2017.11.009

Pour, M. D., Barati, A. A., Azadi, H., Scheffran, J. & Shirkhani, M. (2023). Analyzing forest residents' perception and knowledge of forest ecosystem services to guide forest management and biodiversity conservation. *Forest Policy and Economics*, 146, 102866. https://doi.org/10.1016/j.forpol.2022.102866

Sattayapanich, T., Janmaimool, P. & Chontanawat, J. (2022). Factors Affecting Community Participation in Environmental Corporate Social Responsibility Projects: Evidence from Mangrove Forest Management Project, *Journal of Open*

Innovation: Technology, Market and Complexity, 8, 209. https://doi.org/10.3390/joitmc8040209

Sharma, N., Paço, A. & Upadhyay, D. (2023). Option or necessity: Role of environmental education as transformative change agent. *Evaluation and Program Planning*, 97, 102244. https://doi.org/10.1016/j.evalprogplan.2023.102244

Sunoto, Y. K., Ponrahono, Z. & Osman, M. M. (2020). Profiling the Perceived Mangrove Forest use Value and Community's Willingness to Pay for Mangrove Conservation. *Journal of the Malaysian Institute of Planners*, 18(3), 229 – 240. https://doi.org/10.21837/pm.v18i13.788

Received: 26th June 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 309 – 324

EXAMINING GREEN ATTRIBUTE PREFERENCES IN RESIDENTIAL BUILDINGS: A STUDY IN KANO, NIGERIA

Rohayu Ab Majid[1], Rosli Said[2] & Idris Salisu Barau[3]

[1] UNIVERSITI TEKNOLOGI MARA, MALAYSIA
[2,3] UNIVERSITI MALAYA, MALAYSIA

Abstract

Green building (GB) encompasses a holistic range of environmentally, socially, and economically conscious features addressing sustainability within building design, including energy efficiency, technological innovations, and materials recycling. Within the realm of housing, these integral green attributes synergistically contribute to the creation of living spaces that are not only environmentally friendly but also energy-efficient, health-enhancing, and comfortable. This comprehensive study investigates the paramount aspect of green building through the perspectives of both the general public and experts, assessing their acceptance and support for green building practices in Nigeria, a strategic choice due to its pivotal role within the Green Building Council in Africa, representing one of seven nations. Employing Factor Analysis and the Relative Importance Index, our rigorous analysis scrutinizes residential developments to pinpoint the most influential green building attribute. Our extensive questionnaire, distributed within the bustling metropolis of Kano, Nigeria, selected for its substantial population size in northern Nigeria and its status as the country's second most populous state, unveils a compelling revelation: social attributes wield the most profound influence over the successful implementation of green building practices, emphasizing their central role in sustainable development initiatives.

***Keywords**:* Green Building, Sustainability, Residential Developments, Social Influence, Factor Analysis, Relative Importance Index

[2] Associate Professor at Universiti Malaya. rosli_alambina@um.edu.my

INTRODUCTION

Green building (GB) is valued for its environmentally friendly, energy-efficient, health-enhancing, and comfortable living qualities (Hu et al., 2014). It comprises three dimensions: environmental, social, and economic, leading to research variations on which aspect gains the most widespread acceptance. Results vary due to regional differences, societal norms, and sustainable development levels, all affecting preferences for specific green building attributes.

Sustainability levels differ globally; for instance, Europe, Asia, and Africa display varying degrees of sustainable development (Said et al., 2014, 2016, 2017a&b, 2020, 2022). African nations often lag in social and environmental development, contributing to CO_2 emissions and environmental issues due to fossil fuel use. Conventional building practices globally exacerbate these challenges, posing a major sustainability issue (Olanrele et al., 2020).

African countries, though not major emitters, contribute to CO_2 emissions due to fossil fuel use, impacting climate change. Limited industrialization and infrastructure development in the region worsens the issue. Conventional building practices are a significant CO_2 source (Park et al., 2010), adding to environmental concerns. Sustainability in construction remains a global challenge, rooted in traditional industry methods (Olanrele et al., 2020). Initiatives like Green Building (GB), introduced by organizations such as the Green Building Council (GBC) in 1987, offer diverse solutions for environmental and societal issues (Michael & Rochelle, 2013).

GB tackles energy efficiency, renewables, water conservation, and materials sustainability via recycling, reuse, and reduction, addressing environmental challenges and promoting global sustainability. Nigeria, a developing nation, established its Nigerian Green Building Council (NGBC) in 2014, affiliated with the World Green Building Council (WGBC).

In Kano, Nigeria, despite an increasing number of luxury buildings and estates, there are no green residential or non-residential structures as per the 2016 GBC report. Nonetheless, Dahiru et al. (2014) noted the potential for green building in Nigeria, considering the region's environmental challenges tied to construction projects. Construction industry professionals have shown support for green building concepts to address these concerns. However, a critical question remains: Do households understand green building concepts, and what are their perceptions and willingness to invest in traditional residential buildings? This research aims to uncover these vital insights.

RESEARCH BACKGROUND

Sustainable Development of Green Buildings

80%+ of households live in traditional buildings, but over 50% of global construction projects lack sustainability. Green Building (GB) emerged to drive sustainable development and combat climate change effects, urging the construction industry and experts to act urgently. This addresses environmental preservation amid threats, including construction activities (Saulius et al., 2013).

Buildings serve as vital habitats, offering shelter and comfort when environmentally conscious in design (Ho et al., 2005). Despite people spending most of their time indoors, they often underestimate construction's adverse effects on the environment and society. Construction carries both positive and negative outcomes, including pollution and waste generation (Ali & Nsairat, 2009). While it enhances spatial structure and infrastructure, acknowledging its impact on a nation's overall development is crucial (Daramola et al., 2014)

Countries with developed infrastructure, whether developed or developing, achieve higher sustainable development levels, benefiting their economy, society, and environment (Nduka & Sotunbo, 2014). The interdependence of these three aspects in sustainability is widely acknowledged (Otegbulu, 2011; Ali & Nsairat, 2009; Ho et al., 2005). Nations like France, the UK, and the USA, with a history of economic development, showcase strong societal and environmental sustainability, making green buildings more popular than conventional ones in the pursuit of environmental sustainability.

Conventional buildings provide limited benefits to the environment, society, and the economy. They contribute to environmental degradation and worsening climate conditions. They are responsible for 20-40% of energy consumption (Chau et al., 2010), 10% of global CO_2 emissions (Park et al., 2012), and over one-third of global greenhouse gases (Romero et al., 2013). These negative effects primarily harm society, endangering well-being and hindering economic growth.

Conventional buildings pose several environmental challenges, including energy inefficiency, poor indoor air quality, emissions, high waste generation, and non-environmentally friendly materials. Poor waste management and insufficient sustainable design practices result in pollution during construction, including air pollution, solid waste, and hazardous materials (Michael & Rochelle, 2013). These pollutants contribute to greenhouse gas emissions and climate change. Additionally, conventional buildings have adverse effects on human health, especially occupants.

The three key dimensions of GB (environmental, social, and economic) have been subjects of research to determine their importance and acceptance levels (Said et al., 2016, 2017, 2020). Additionally, Zuo & Zhao (2014) identified research gaps, categorizing studies based on assessment tools' effectiveness, specific population demands, and future-proofing considerations. Understanding the demand for green buildings is crucial, as preferences depend on desired attributes and the population's willingness to adopt them.

Green Building Attributes

Existing studies on green building, involving various researchers (Ho et al., 2005; Paul & Taylor, 2007; Ali & Nsairat, 2009; Achinicht, 2010; Zalejska-Jonsson, 2012; Kim et al., 2013; Dahiru et al., 2014), have explored its dimensions: environment, society, and economy. They've identified factors emphasizing societal benefits due to green building eco-friendliness, energy efficiency, health, and comfort (Hu et al., 2014). Green building development's success hinges on household perceptions, preferences, and willingness to pay (WTP). These preferences, expressed by residents or rated by systems like LEED, BREEAM, and HK-BEAM, are considered attributes of green buildings. Some research suggests these attributes positively affect economic gains, such as utility benefits, making users more inclined to pay for green buildings, thereby increasing demand in the real estate market.

Goodwin (2011) summarized research on green building demand from 1975 to 2010, categorizing perspectives based on attributes. Banfi et al. (2008) focused on the willingness to pay for environmental attributes. It's crucial to note that results can vary across regions due to different behaviours and attitudes among respondents. Goodwin (2011) noted differences in outcomes between studies in the USA, Switzerland, and Sweden. Many studies have explored attributes within specific populations, such as Achinicht's (2010) German study, where homeowners prioritized environmental benefits (heating systems) over insulation choices in a choice experiment.

Green building attributes significantly influence demand for conventional buildings, with homebuyers willing to pay for them. In Nanjing, China, high-income individuals paid more for improved comfort, while both high and low-income respondents paid extra for unpolluted environments and non-toxic materials in good locations (Hu et al., 2014). In Hong Kong, both green and conventional residents were willing to pay more for energy conservation compared to indoor air quality, noise reduction, landscape enlargement, or water conservation (Chau et al., 2010). Hu et al. (2014) identified five attributes affecting willingness to pay, three benefiting households, and two focusing on environmental conservation (unpolluted environment and non-toxic materials), with only higher-income individuals willing to pay for these.

In the UK, attracting potential tenants requires effectively communicating tangible cost savings from energy-efficient buildings (Adan & Fuerst, 2015). Green building buyers also value better health conditions. Besides green building attributes, the living environment, including location and neighbourhood quality, influences housing decisions. Western countries show a higher willingness to pay for factors like job opportunities, cleanliness, security, avoiding landfills, and air quality over amenities like gyms and cultural services, possibly due to health-related concerns (Achinicht, 2010).

Based on the literature review, the authors have identified various attributes of green buildings across different dimensions. These attributes include comfort, health, unpolluted environments, non-toxic materials, good locations (Ali & Nsairat, 2009); energy bill reduction, CO_2 emission reduction, volatile organic compound emission reduction, and IT facility application (Park et al., 2012); energy conservation, indoor air quality improvement, noise reduction, landscape enlargement, and water conservation (Chau et al., 2010); and various aspects of comfort and satisfaction (Paul & Taylor, 2007). Additional attributes encompass site, material, water, energy, indoor environmental quality (Ho et al., 2005); land use, soil change, light environment, transportation, residential environment usability, energy resource-saving, environmental pollution, water resources management, green space construction, living space for biodiversity, and atmosphere and noise environments (Kim et al., 2013). Lastly, there are attributes related to lower energy costs, annual electricity and water cost reduction, long-term fuel cost reduction, preservation of water resources, expanding market for eco-friendly products, reduced health impacts, improved occupant satisfaction and comfort, and increased transportation options for employees (Waidyasekara & Fernando, 2012).

METHODOLOGY

As previously discussed, the attributes of green buildings can be categorized into three dimensions: environment, society, and economy. Each of these dimensions has implications for the development of residential and other types of green buildings. To assess the demand for residential green buildings within a specific population, it is essential to determine the preferences for these attributes, which can be measured using the Relative Importance Index (RII). Subsequently, another test, such as Factor analysis, can be conducted to explore the relationships and correlations among these attributes.

Data Collection

This survey employs a field survey approach to collect firsthand information from participants who rank factors influencing household satisfaction, aiming to assess support for improving conventional buildings in Kano, Nigeria. The field survey aids in clarifying measurements and utilizes the Likert Scale (Said et al., 2016, 2017, 2020), where respondents rate attributes on a scale of 1 (very low) to 5 (very high).

The survey questionnaire consists of two parts, each with two sections. Part One's first section gathers demographic information with nine questions. Part Two, the second section, lists green building attributes influencing the state's preference for residential green building implementation.

Part One includes 43 variables, while Part Two encompasses 28 variable sets. These attributes are drawn from literature, household data, and state authorities. Furthermore, the green building attributes are categorized into three dimensions as follows:

i) Environmental Attributes
ii) Social Attributes
iii) Economic Attributes

The respondent survey utilizes random sampling to gauge public and expert support for green building development in Kano State, Nigeria. Kano State, positioned between latitudes 10° 33'N and 12° 23'N and longitudes 7° 45'E and 9° 29'E, had a 2006 census population of 9,401,288. Located in northern Nigeria, it shares borders with Jigawa, Katsina, Kaduna, and Bauchi. Second in population only to Lagos, it spans 20,131 sq. km (3.13% of Nigeria's total area) and comprises 44 local government areas. Kano State is divided into three geopolitical zones: Kano Central, Kano South, and Kano North, and plays a pivotal role as a commercial hub in northern Nigeria. (Adebayo et al., 2013; Naibbi & Healey, 2013). Figures 1 and 2 display the positions of Nigeria and Kano State on the Nigerian map, respectively.

Figure 1: Map of Nigeria
Source: Wikimapia (2023)

Figure 2: Map of Kano State, Nigeria
Source: Wikimapia (2023)

We used random sampling to ensure diverse representation. We distributed 350 questionnaires in Kano State to both the general public and experts from various professions, categorizing all as Kano metropolis households (Table 1), with respondent ages ranging from 20 to 50+ within each household.

Table 1: Respondents of Kano Metropolis

Questionnaire Distributions	
Kano metropolis	Specific Areas Distributed
1.Kano Municipal	Zage, Zango, K/mata
2.Gwale	BUK, G/Kyaya
3.Dala	Koki, K/Wambai
4.Tarauni	Yan Gwan-gwan
5.Nasarawa	GRA, Alfurkan
6.Fagge	Bata, Kwari

DATA ANALYSIS

Data analysis involved using the Relative Importance Index (RII) method to assess each factor's contribution in improving conventional residential buildings, based on respondent perceptions. Factor analysis (FA) then extracted key factors from the dataset.

Relative importance index

Relative importance refers to the proportionate contribution that each predictor makes to R^2, taking into account both its individual impact and its incremental effect when combined with other predictors (Johnson & LeBreton, 2004; Wood et al., 2019).

$$\text{RII} = \frac{\sum W}{A \times N} (0 \leq RII \leq 1)$$

Where;
RII = Sum of weights (W1 + W2 + W3 + W4……+ Wn) / A x N
W = weights given to each attribute (i.e., 1 to 5 where '1' is very low important and '5' is very highly important.
A = highest weight (i.e., 5 in this case)
N = total number of respondents

Factor Analysis

Factor analysis, as utilized by Htet & Wongsunopparat (2021), reveals latent variable dimensions by reducing the attribute space. It operates independently of a specified dependent variable and serves various purposes:
·Reducing variables for modelling.
·Confirming test convergence, and reducing test administration.
·Validating scales or indices.
·Selecting variables based on their correlation with principal components.
In this research, factor analysis validates the index obtained from RII, assessing support for green building attributes.

RESULTS

Respondents' Profile

Table 2 presents the respondent's background, categorized into the respondent profile, housing information, and income. Examples of these categories include gender, age, marital status, education, and employment.

Table 2: Respondents' Profile

Profile information	Category	Frequency	Percentages (%)
Gender	Male	152	76.0
	Female	48	24.0
	Total	200	100.0
Age(years)	20 and Below	6	3.0
	21 – 30years	69	34.5
	31 – 40years	68	34.0
	41 – 50years	46	23.0
	51 and above	11	5.5
	Total	200	100.0
Marital status	Single	64	32.0
	Married	122	61.0
	Divorced	14	7.0
	Total	200	100.0
Education	Diploma	48	24.0
	Degree	80	40.0
	Masters	31	15.5
	PhD	10	5.0
	Others	31	15.5
	Total	200	100.0
Employment	Civil servant	80	40.0
	Private	65	32.5
	Pension	13	6.5
	Unemployed	32	16.0
	Others	10	5.0
	Total	200	100.0

Using a five-point response scale (Tables 3(a)-(c)), RII generates values from 0.1 to 1.0. The group index averages RII scores within the environment, social, and economic categories. Social (Table 3(a)) had the highest average RII score of 0.663, followed closely by environment (0.642) and economic (0.633). This highlights social aspects as most important in green building preferences, particularly emphasizing a clean environment, aligning with Ali & Nsairat's (2009) findings. Therefore, ensuring cleanliness during construction is crucial for residential development.

Table 3 (a): Relative Important Index of Social Attributes

Factor	1	2	3	4	5	W	RII	Rank
Social attributes							**0.663***	**1**
Site drainage patterns	23	29	49	47	52	676	0.676	
Operation and maintenance	19	37	46	54	44	667	0.667	
Waste management (recycle/reduce)	31	22	59	55	33	637	0.637	
Location (bad/fair/good)	16	23	60	47	54	700	0.700	
Site selection	17	29	67	48	39	663	0.663	
Building orientation	20	38	69	39	34	629	0.629	
Daylight consideration	13	18	75	57	37	687	0.687	
Ventilation	14	32	52	52	50	692	**0.692**	
Building designing (in-house/expert design)	10	27	68	49	46	694	**0.694**	
Landscape area enlargement	24	31	56	56	33	643	0.643	
Adverse health impacts	15	30	60	56	39	674	0.674	
Transportation options for employee	21	38	52	56	33	642	0.642	
Information Technology facilities	25	24	65	48	38	650	0.650	
Waterways	22	32	68	40	38	640	0.640	
Noise level (low/high)	27	27	63	42	41	643	0.643	
Painting colour (i.e. gold/green/white/brown)	23	42	58	46	31	620	0.620	
Access to amenities	17	35	43	49	56	692	0.692	
Well and Borehole	43	25	36	44	52	637	0.637	
Building quality	14	27	46	55	58	720	**0.720**	
Crowding	32	39	66	37	26	586	0.586	
Environment (Clean/unclean)	14	22	45	53	66	735	**0.735**	

Respondents ranked the environment group second in influence on residential green buildings. Key factors in this category were connecting with nature (RII 0.686), environmentally friendly construction (RII 0.671), and lighting environment (RII 0.664) (Table 3(b)). These findings support Achinicht (2010) and Daramola et al. (2014), emphasizing the importance of aligning housing policies with environmental protection, as suggested by Dahiru et al. (2014).

Table 3 (b): Relative Important Index of Environment Attributes

Factor	1	2	3	4	5	W	RII	Rank
Environment attributes							**0.642***	**2**
Environmental issues (polluted/Unpolluted)	46	31	52	23	48	596	0.596	
Materials used in construction	23	47	55	35	40	622	0.622	
CO_2 emissions (high/low)	35	34	77	26	28	577	0.577	
Living space for biodiversity	18	30	63	59	30	652	**0.652**	
Connecting with Nature	15	28	58	57	42	686	**0.686**	
Water conservation (reduce/recycle)	25	44	62	42	27	604	0.604	
Construction of green space	22	30	65	50	33	645	**0.645**	
Lighting environment	19	33	50	64	34	664	**0.664**	
Protection of ecological resources	22	41	60	40	37	632	0.632	
Air pollution (increase/Reduce)	30	24	52	45	49	662	0.662	
Environmentally-friendly construction	13	32	62	59	34	671	0.671	
Soil and water conservation	18	32	59	54	37	660	0.660	
Land preservation	16	38	58	53	35	653	0.653	
Energy use (efficiency/renewable)	16	32	66	54	32	654	0.654	
Microclimate Factors (solar &wind loads)	30	24	58	47	41	645	0.645	

Economic benefits (Table 3(c)) had the lowest average RII (0.633), indicating lower importance compared to social and environmental aspects. Though the score gap isn't wide, it's around 0.6. Individually, energy cost issues ranked highest (RII), supported by Waidyasekara & Fernando (2012), followed by expanding the market for environmentally preferable products (green building), making them the most beneficial and economical aspects in adopting green concepts in Kano, Nigeria.

Table 3 (c): Relative Important Index of Economic Attributes

Factor	1	2	3	4	5	W	RII	Rank
Economic attributes							**0.633***	**3**
Energy costs (high/low)	27	28	73	37	35	629	0.629	
Local recycling market (building materials)	25	38	69	35	33	613	0.613	
Expand the market for environmentally preferable products(green building)	20	30	63	54	33	650	0.650	
Use of Recyclable materials	22	38	69	50	21	610	0.610	
Energy issues (efficiency/renewable)	21	28	61	58	32	653	0.653	
Labour cost (Manpower/machine/material)	18	26	78	49	29	645	0.645	

Factor Analysis

The primary aim of the Factor analysis (FA) was to validate the index findings by identifying and enumerating the list of important components, following the approach suggested by Zatoril et al. (2018). To assess the adequacy of the FA, the accepted criteria relied on the Kaiser-Meyer-Olki (KMO) and Bartlett's Test. The KMO is a measure of sampling adequacy (Figure 3), and generally, a KMO value within the range of 0.6 to 0.9 indicates that the sample is sufficient and acceptable, with values of 0.8 to 0.9 considered particularly favourable (Sahbaeiroy, 2018). In this analysis, the KMO value is calculated to be 0.849 for all variables, indicating that the sample is adequate for further analysis and validation of the findings.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.849
Bartlett's Test of Sphericity	Approx. Chi-Square	3112.623
	Df	861
	Sig.	.000

Figure 3: KMO and Bartlett's Test

Table 4 reveals 12 components extracted from the initial set of 43 variables via factor analysis, encompassing key aspects of green building (environmental, economic, and social). The primary factor is social, closely linked to environmental factors and less so to the economic group. These factors include waste management, unpolluted environment, biodiversity-friendly living spaces, connecting with nature, operation and maintenance, lighting, environment, soil and water conservation, among others.

Additionally, social attributes merge with economic attributes as a selective component, with the environment group more relevant to the completion phase. Attributes like indoor ventilation, occupant habitability, annual electricity costs, consistent electricity supply, occupant health, renovation and demolition costs, and indoor daylight play significant roles in household satisfaction. These components offer valuable insights into preferences for green building attributes.

Table 4: Component Extraction

Factors/Components	Questionnaire title	Extraction	Rank
Waste management (recycle/reduce)	SOCIAL ATTRIBUTE 3	0.781	1
Environmental issues (polluted/Unpolluted)	ENVIRONMENT ATTRIBUTE 1	0.758	2
Living space for biodiversity	ENA4	0.721	3
Connecting with Nature	ENA5	0.721	4
Operation and maintenance	SOA2	0.696	5
Lighting environment	ENA8	0.690	6
Soil and water conservation	ENA12	0.686	7
Microclimate Factors (e.g. solar &wind loads)	ENA15	0.685	8
Information Technology facilities	SOA13	0.683	9
Building quality	SOA19	0.678	10
Protection of ecological resources	ENA9	0.677	11
Building designing (in-house/expert design)	SOA9	0.677	12

The assessment acknowledges that initially, only social and environmental attributes were extracted, and no economic grouping variables were included to validate the findings of the Relative Importance Index (RII). Consequently, we can conclude that the social attributes exhibit distinct characteristics when analyzed using FA and RII.

CONCLUSIONS

The study employed the Relative Importance Index (RII) and Factor Analysis (FA) to analyze and identify key attributes of residential buildings. It examined the most influential factor within the dimensions of green residential buildings, both in the preliminary and completion stages, focusing on household benefits. The preliminary stage is most influenced by variables from the social and environmental groups, while the completion stage is significantly influenced by attributes from the environmental and social dimensions, all of which relate to end-user benefits.

In the real estate sector, land and property development is notably expensive compared to other industries worldwide. Conventional buildings often lead to issues like energy inefficiency, poor indoor quality, emissions, excessive waste, and non-environmentally friendly construction materials. These shortcomings, along with inadequate waste management and design considerations, directly impact households.

To address these challenges and promote sustainable building practices, the concept of green buildings has emerged. Green buildings integrate various features related to the environment, society, and economy to create eco-friendly, energy-efficient structures. In this study, the Relative Importance Index (RII) and Factor Analysis (FA) determined the most important attribute based on household preferences. The research involved distributing questionnaires to households in Kano, Nigeria's metropolis.

The findings revealed that, among the three aspects of green building, the social attribute held the greatest influence on household preferences. This highlights that building designs emphasizing social factors, like community well-being and environmental awareness, have the most significant impact on the support and acceptance of green building concepts among surveyed households.

REFERENCES

Achinicht, M. (2010). Do Environmental Benefits Matter? A Choice Experiment Among Housing Owners in Germany. ZEW Discussion Paper 10-094, 1-24.

Adan, H., & Fuerst, F. (2015). 23 Million Upgrading Decisions: A Microeconomic Approach to Understanding Green Investments in the UK Housing Market. University of Cambridge, Department of Land Economy, 1-27.

Adebayo, O., Ayuba, P., Oyrtola, S., & Audu, H. (2013). Analysis of User's Perception on How to Achieve Thermal Comfort in Kano State Luxury Homes. Developing Country Studies, 1-11.

Ali, H. H., & Nsairat, S. A. (2009). Developing a green building assessment tool for developing countries - A case of Jordan. *Building and Environment*, 1053–1064.

Banfi, S., Farsi, M., Filippina, M., & Jakob, M. (2008). Willingness to pay for energy-saving measures in residential buildings. *Energy Economic*, 503-516.

Chau, C., Tse, M., & Chung, K. (2010). A choice experiment to estimate the effect of green experience on preference and willingness-to-pay for green building attributes. *Building and Environment,* 2525-2561.

Claveria, O. (2021), A new metric of consensus for Likert-type scale questionnaires: an application to consumer expectations. J Bank Financ Technol 5, 35–43. https://doi.org/10.1007/s42786-021-00026-5

Dahiru, D., Dania, A. A., & Adejoh, A. (2014). An Investigation into the Prospects of Green Building Practice in Nigeria. *Journal of Sustainable Development*, 158-167.

Daramola, A., Oluwatoyin, A., & Oladele, A. (2014). Housing Infrastructural Development and Green Building Strategies in Nigeria. *Journal of Emerging Trends in Economics and Management Sciences*, 281-288.

Goodwin, K. R. (2011). The Demand for Green Housing Amenities. *JOSRE*, 127-141.

Ho, D. &., Yau, Y., Cheung, A., & Wong, S. (2005). Comparative Study of Building Performance Assessment Schemes in Hong Kong. *Hong Kong Surveyor*, 47-58.

Htet, Y. K. K. & Wongsunopparat, S. (2021). Study Of Factors That Effect and Influence on The Personal Financial Management of The Young Adult. *Journal of Empirical Economics and Social Sciences*, 3 (1), 79-100. DOI: 10.46959/jeess.809250

Hu, H., Geertman, S., & Hooimeijer, P. (2014). The willingness to pay for green apartments: The case of Nanjing, China. *Urban Studies,* 3459–3478.

Kim, M. J., Oh, M. W., & Kim, J. T. (2013). A method for evaluating the performance of green buildings with a focus on user experience. *Energy and Buildings,* 203-210.

Michael, R., & Rochelle, A. (2013). Construction costs comparison between 'green' and conventional office buildings. *Building Research & Information*, 198–208.

Naibbi, A. I., & Healey, R. G. (2013). Northern Nigeria's Dependence on Fuelwood: Insights from Nationwide Cooking Fuel Distribution Data. *International Journal of Humanities and Social Science*, 160-173.

Nduka, D. O., & Sotunbo, A. S. (2014). Stakeholders' Perception on The Awareness of Green Building Rating Systems and Accruable Benefits in Construction Projects in Nigeria. *Journal of Sustainable Development in Africa*, 118-130.

Olanrele, O. O., Alias, A., Said, R., Bello, N. A. (2017). Towards global uniformity and sustainable compensation valuation for compulsory land acquisition. Journal of Design and Built Environment, 17, 27-37.

Olanrele, O.O., Said, R., Daud, M.N., & Majid, R.A. (2018), REIT Financing of Real Estate Development Projects in Nigeria: Why Not? *Journal of Design and Built Environment*, Special Issue (1), University of Malaya, pp 102-115.

Olanrele O.O., Fateye O.B., Adegunle T.O., Ajayi C.A., Said R., Baaki K. (2020). Causal effects of macroeconomic predictors on real estate investment trust s (REIT s) performance in Nigeria, *Pacific Rim Property Research Journal. 26*(2), 149-171. doi:10.1080/14445921.2020.1857498

Otegbulu, A. (2011). Economics of Green Design and Environmental Sustainability. *Journal of Sustainable Development,* 240-248.

Park, M., Hagishima, A., Tanimoto, J., & Chun, C. (2012). Willingness to pay for improvement in environmental performance of residential buildings. *Building and Environment*, 225- 233.

Paul, W. L., & Taylor, P. A. (2007). A comparison of occupant comfort and satisfaction between a green building and a conventional building. *Building and Environment*, 1858-1870.

Romero, M. M., Krogmann, U., Wallbaum, H., Ostermeyer, Y., Senick, J. S., & Andrews, C. J. (2013). Relative importance of electricity source and construction practices in residential building: A Swiss-US comparison of energy-related life-cycle impacts. *Energy and Buildings*, 620-631.

Sahbaeiroy, F. (2018). Design and Psychometric of Smoking Cessation Instrument according to Precaution Adoption Process Model in Patients Hospitalized in Hospitals Affiliated to Medical University of Babol, Iran, during 2017. *Asian Journal of Pharmaceutics* (AJP), 12(01). https://doi.org/10.22377/ajp.v12i01.2084

Said, R., Adair, A., McGreal, S., & Majid, R. (2014). Inter-relationship between the housing market and housing finance system: Evidence from Malaysia. *International Journal of Strategic Property Management, 18*(2), 138-150.

Said, R., Majid, R. A., Alias, A., Adnan, Y. M., Razali, M. N. (2016). Sustainable housing affordability in Sabah. *Planning Malaysia* (5), 65-76.

Said, R., Majid, R. A., Daud, M. N., Esha, Z., Razali, M. N. (2017_a). Owners' perception towards sustainable housing affordability in Kuching, Sarawak. *Journal of Design and Built Environment*, 17, 194-206.

Majid, R. A., Said, R., Chong, J. T. S. (2017_b). Assessment of bubbles in the Malaysian housing market. Planning Malaysia, 15(3), 27-38.

Said, R., Majid, R. A., Pey, K. C., & Olanrele, O. O. (2020). Ascertaining the business sustainability of heritage properties in Malaysia. *International Real Estate Review, 23*(4), 1163-1185.

Said R., Majid R.A., Akinsomi O., Hishamuddin M.I. (2022). Sustainability of Residential Investment in Klang Valley, Malaysia, *Journal of Design and Built Environment. 22*(3), 124-139

Saulius, R., Andrius, S., & Edita, J. (2013). Sustainability Assessment Studies of Recreational Buildings. 11th International Conference on Modern Building Materials, *Structures and Techniques,* MBMST 2013 (pp. 929-937). Vilnius: Elsevier.

Waidyasekara, K., & Fernando, W. (2012). Benefits of Adopting Green Concept For Construction Of Buildings In Sri Lanka. ICSBE, 1-13.

Wikimapia, http://wikimapia.org/country/Nigeria/Kano/Kano/. Retrieved 18 August 2023.

Wood, D., Lowman, G. H., Harms, P. D., & Roberts, B. W. (2019). Exploring the relative importance of normative and distinctive organizational preferences as predictors of work attitudes. *Journal of Applied Psychology, 104*(2), 270–292. https://doi.org/10.1037/apl0000356

Zalejska-Jonsson, A. (2012). Evaluation of low-energy and conventional buildings from occupants' perspective. *Building and Environment*, 135-144.

Zatoril A., Smith, M.K. & Puczko, L. (2018), Experience-involvement, memorability and authenticity: The service provider's effect on tourist experience, *Tourism Management*, Volume 67, Pages 111-126. https://doi.org/10.1016/j.tourman.2017.12.013

Zuo, J. and Zhao, Z.Y., (2014) "Green building research-current status and future agenda: A review," *Renew. Sustain. Energy Rev.*, vol. 30, pp. 271-2

Received: 7th June 2023. Accepted: 5th September 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 325 – 340

LAND SUBSIDENCE DYNAMICS IN MALAYSIA BASED ON TIME-SERIES VERTICAL DEFORMATION USING MODIFIED D-INSAR SENTINEL-1

Atriyon Julzarika[1]

[1]*Research Centre for Geospatial,*
NATIONAL RESEARCH AND INNOVATION AGENCY (BRIN)

Abstract

Land subsidence in urban areas is geohazard that can be caused by tectonic movements, changes in aquifer networks, or anthropogenic activities such as excessive groundwater extraction, mining, tunnelling, and plantations. The degree of land subsidence can be monitored using time-series vertical deformation data extracted from Sentinel-1 satellite imagery using the modified D-InSAR method. This study aims to determine the land subsidence dynamics of 16 cities in Malaysia based on time-series vertical deformation data, including Kota Bahru, Kuala Terengganu, George Town and Butterworth, Alor Setar, Kangar, Ipoh, Seremban, Malacca, Kuala Lumpur, Putra Jaya, Shah Alam, Kuantan, Johor Bahru, Kinabalu, Bandar Labuan (Victoria), and Kuching. The time-series vertical deformation data used in this study were extracted between 2014-2022. Negative values of vertical deformation indicate that land subsidence is occurring, while positive values of vertical deformation are indicative of regional uplift. The overall rate of land subsidence in Malaysia is between -0.5 cm to -6.0 cm, while the average uplift rate is between +0.5 cm to +4.5 cm. An analysis of the data extracted reveals that the city that is most vulnerable to land subsidence is Johor Bahru, followed by Kuala Terengganu, Seremban, Kuala Lumpur, Shah Alam, Malacca, and Kuantan, while the city that has the lowest risk of land subsidence is Kangar. In contrast, cities that are vulnerable to regional uplift are Kinabalu and Bandar Labuan (Victoria). The results of this study can be used to guide urban planning initiatives, allowing them to consider any threats that might be posed by land subsidence.

Keywords: Land Subsidence, Time-Series Vertical Deformation, Modified D-InSAR, 16 cities of Malaysia

[1] Senior Researcher at National Research and Innovation Agency (BRIN), e-mail: verbhakov@yahoo.com

INTRODUCTION

Malaysia is a Southeast Asian country that has undergone significant urban development in recent years. The development of cities has been characterized by the addition of residential districts, increased population density, increasingly accessible transportation services, and topographical changes. One of the major geohazards that large cities face is land subsidence. Land subsidence is a geological hazard phenomenon (Motagh et al., 2017; Zhu et al., 2015). Land subsidence is becoming an increasingly important problem in Malaysia, with several cities experiencing some form of land subsidence (Muhammad et al., 2021). Land subsidence is most commonly caused by active tectonic movement but can also be due to anthropogenic activities (Julzarika et al., 2021). Excessive groundwater extraction, tunnelling, excessive infrastructural development, and mining activities that may disrupt aquifers are the example of anthropogenic activities (Ardha et al., 2021; Julzarika et al., 2022; Muhammad et al., 2021).

The Malaysian area less experienced land subsidence due to the tectonic movement. Land subsidence in large cities in Malaysia is more likely to be caused by groundwater extraction. Cities such as Kuala Lumpur and Johor Bahru have undergone a significant degree of residential development as well as an increase in population density, while regions such as Kota Bahru (Kelantan) represent approximately 38 % of the national groundwater demand. These factors have resulted in an increase in groundwater consumption from 1990 to 2010 (Suratman, 2012). Rates of land subsidence in Malaysia are still relatively low, especially when compared to regions such as the northern Java, California, and the northern Africa (Ardha et al., 2021; Mohamed & Gonçalvès, 2021; Stampoulis et al., 2019). This phenomenon is still concerning to local governments and residents, and the steps should be taken to ensure that future incidents do not occur. Consequently, land subsidence monitoring is key in areas that encompass fault boundaries or in large, dynamic cities (Suhadha et al., 2021). Land subsidence can impact a community's economy, disrupt regional and urban planning, and damage existing infrastructure, such as by disrupting underground utility lines, allowing for seawater intrusion, damaging the foundations of buildings, and increasing the risk of tidal flooding. The primary concerns are the impact on the environment as well as the impacts on the urban economy associated with asset loss. This study aims to analyse the land subsidence dynamics in Malaysia based on modified Differential Interferometry Synthetic Aperture Radar (D-InSAR) from Sentinel-1.

RESEARCH METHODOLOGY

Study Area

This research area is located in 16 cities of Malaysia. The selection of these 16 cities was based on regional administrative conditions (state capital), population density, and groundwater consumption potential. Population density has a linear correlation with groundwater consumption potential. The 16 cities referred to in this study can be seen in Figure 1. The 16 cities include (1) Kota Bahru, (2) Kuala Terengganu, (3) George Town and Butterworth, (4) Alor Setar; (5) Kangar, (6) Ipoh, (7) Seremban, (8) Malacca, (9) Kuala Lumpur, (10) Putra Jaya, (11) Shah Alam, (12) Kuantan, (13) Johor Bahru, (14) Kinabalu, (15) Bandar Labuan (Victoria), and (16) Kuching.

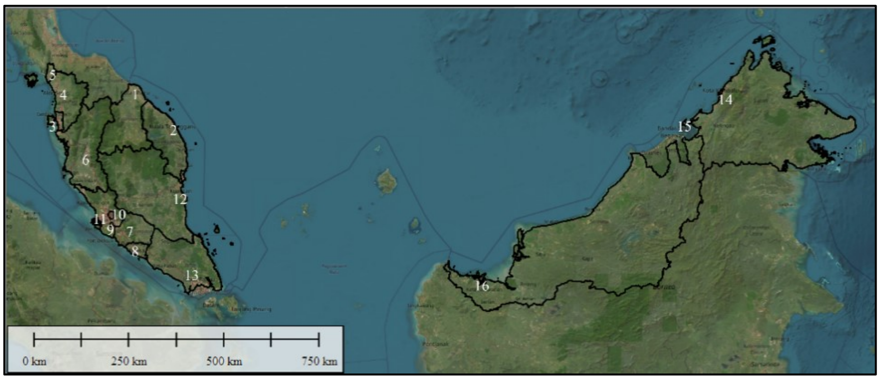


Figure 1: Study Area in 16 Cities of Malaysia
Source: Author modification from World Imagery

D-InSAR and Sentinel-1

D-InSAR is an active remote sensing technique based on the principle of analysing paired and co-registered SAR images with different acquisition times to detect displacements down to subcentimeter along the sensor's line of sight to the target or Line of Sight (LOS) (Suhadha & Julzarika, 2022). It is similar to terrain motion measurement. This method can be used for efficient and effective mapping and to complement the deficiencies of existing field survey data (Devanthéry et al., 2016). Sentinel-1 imageries are used to extract the vertical deformation using modified D-InSAR. The Sentinel-1 is a radar satellite (C band sensor) with a spatial resolution of 5 to 10 m and a temporal resolution of 6 to 12 days (ESA, 2019).

The modified D-InSAR method is a modified method of the traditional D-InSAR, P-SBAS, and PS-InSAR, which has taken into account the error propagation in the model and data used and has changed the final result of vertical deformation LOS to vertical deformation (true) (Julzarika et al., 2022; Suhadha et al., 2021). The result of vertical deformation is still in the form of LOS, so it is necessary to make nadir corrections or vertical deformation (true). LOS vertical deformation means that the oblique vertical deformation value corresponds to the direction of the satellite's viewing angle to the ground surface, see equation (1) (Ferretti et al., 2007; Rucci et al., 2012). Vertical deformation (true) means that the resulting vertical deformation value has been nadir corrected or perpendicular to the nadir. The vertical deformation value (true) is close to the actual value in the field; see equation (2) (Suhadha et al., 2021).

Vertical deformation (LoS) = $2\pi\Delta r / \lambda = (4\pi * B * q) / (\lambda * R)$ *……………… equation (1)*

*Vertical deformation (true) = vertical deformation (LoS) * cos* θ *…….. equation (2)*
θ *= incidence angle; B = the perpendicular baseline; q = the displacement between the resolution cell along the perpendicular to the slant range; R = the radar target distance;* λ *= SAR wavelength*

The D-InSAR results still have low vertical accuracy, so it is necessary to integrate with several field measurement points. Measurements with D-InSAR focus on results in precise vertical deformation (Julzarika et al., 2022; Rucci et al., 2012). Field data brings the value of vertical deformation according to the existing reference plane on the earth's surface. This method can complement the need for more available field survey data. The D-InSAR and field data integration results will produce high-precision and high-accuracy vertical deformation measurements over a wide area. Vertical deformation monitoring is critical to support security and regional planning, especially in areas with dynamic land use changes and cities like Malaysia.

RESULTS AND DISCUSSION

The results of this study are the time-series vertical deformations across Malaysia between 2014-2022. The results were analysed using accuracy and profile tests. The results of the vertical deformation analysis can be used to determine whether the city is experiencing land subsidence or uplift. Vertical deformation on the Earth's surface geodynamics can be categorised into land subsidence and uplift. Land subsidence is a vertical deformation with a negative value, while uplift is a vertical deformation with a positive value. This negative value means a decrease in the surface, while a positive value means an increase in the surface.

Our analysis revealed a significant global vertical deformation anomaly in 2020-2021. This anomaly refers to abnormal changes in vertical deformations, such as the occurrence of extremely rapid rates of land subsidence or instances of extreme uplift. More simply, the global vertical deformation anomaly can be described as the opposite of previous vertical deformation patterns. The impact of the global vertical deformation anomaly causes irregularities in the geodynamic movements. It is away from the equilibrium point of tectonic movements and changes the composition pattern of land 29% and water 71%. Figure 2 is the global vertical deformation anomaly. In 2020, there was a significant negative vertical deformation anomaly that affected most of Malaysia.

Several areas experienced uplift during the global vertical deformation anomaly, especially in areas where subsidence had occurred before 2020.

In addition, there was an episode of vertical deformation in 2021-2022 in the opposite direction of the deformation observed during 2020-2021 anomaly. For example, if extreme subsidence had occurred in 2020-2021, then the same area would have experienced extreme uplift during 2021-2022, effectively returning the regions to the equilibrium (balance movements) conditions experienced prior to the 2020 anomaly. Similarly, areas that experienced extreme uplift during the 2020-2021 anomaly experienced extreme subsidence 2021-2022. The following are the results of the vertical deformation dynamics and cross-section profile patterns in 16 cities in Malaysia. The locations of these 16 cities are grouped into the west coast of Peninsular Malaysia, the east coast of Peninsular Malaysia, and East Malaysia.

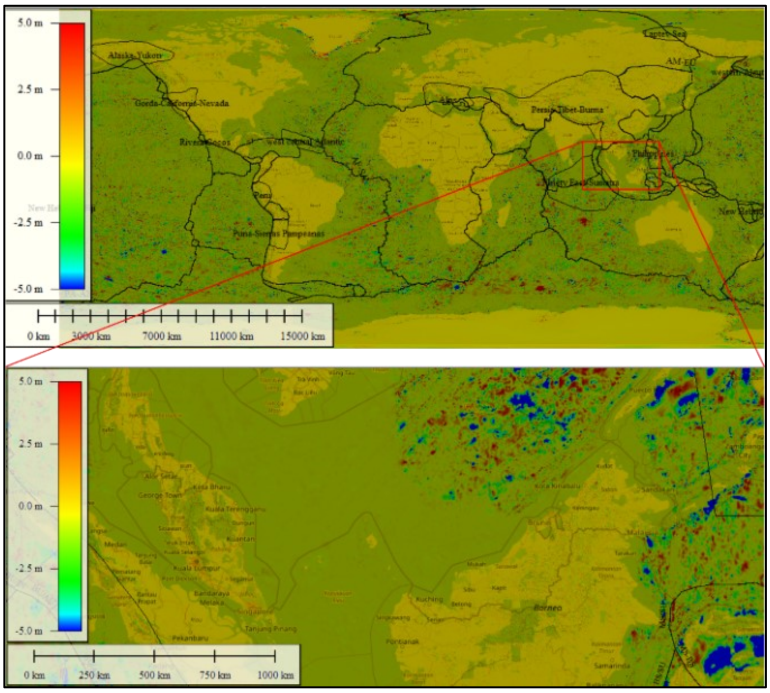


Figure 2: Global Vertical Deformation Anomaly 2020-2021
Source: Author calculation (2020-2022)

(1) West Coast of Peninsular Malaysia

The west coast of Peninsular Malaysia includes Kangar, Alor Setar, George Town and Butterworth, Ipoh, Seremban, Kuala Lumpur, Putra Jaya, Shah Alam, and Malacca. Kangar is a city near the Thailand border that experiences lower land subsidence, see Figure 3(A). In 2014-2020, there was a subsidence of -0.5 cm. In 2020, this region was affected by the effects of the global vertical deformation anomaly. Kangar experienced an extreme uplift of +10.0 cm. This uplift condition is due to the area around Kangar experiencing a subsidence movement so that the city is surrounded and affected by a balancing movement towards the surrounding area. There will be a subsidence of -0.5 cm in 2021, but this region has yet to reach equilibrium after the global vertical deformation anomaly. The impact of the 2021 subsidence will cause more significant subsidence in 2022. The 2022 subsidence value is -9.0 cm. In addition to natural balance factors, it can also be caused by groundwater extraction or changes in the aquifer networks. Overall, Kangar did not experience any significant vertical deformation during the 2020-2022 period. In 2022, the vertical position of Kangar will be almost the same as the vertical position in 2020. Some areas in Kangar will experience land subsidence of -0.5 cm, and some areas in Kangar will experience an uplift of +0.5 cm. Kangar is an example of an ideal area in Malaysia that experiences a balance of tectonic movements and moderate consumption of groundwater.

Alor Setar is the capital of the state of Kedah. Alor Setar is located in the northern part of Peninsular Malaysia. The Alor Setar area has soft soil conditions, and the large Kedah River crosses it. Parts of Alor Setar are river deltas and are prone to sedimentation. Soft soil conditions cause vulnerability to land subsidence, while sedimentation causes vulnerability to uplift. In 2014-2020, Alor Setar was dominated by land subsidence of -0.5 cm, see Figure 3(B). In 2020, Alor Setar was affected by a global vertical deformation anomaly, which caused an uplift of +2.5 cm. Likewise, in 2021, Alor Setar will experience another uplift of +3.0 cm. High sedimentation also affects the uplift value in 2020-2021. In 2022, a tectonic equilibrium occurred and caused Alor Setar to experience a subsidence of -7.0 cm. These conditions are close to the vertical position as before 2020. In the 2020-2022 period, Alor Setar experienced land subsidence of -1.5 cm. The condition of the vertical deformation movement, which sometimes subsides and sometimes uplifts, is also influenced by anthropogenic activities and the major flood that hit Alor Setar. For example, floods in 2022 will occur in a wide area, and extended inundation is caused by high land subsidence. Another factor that caused the uplift in 2020-2021 and high subsidence (-7.0 cm) in soft soil is the aquifer networks changes, and surface water from rain becomes easily stagnant on the surface.

George Town is the state capital of Pulau Pinang. It is located on an island and is separated from Peninsular Malaysia. The opposite side east of George Town is Butterworth. In 2014-2020, George Town and Butterworth experienced land subsidence of -2.0 cm, see Figure 3(C). In 2020, these two cities experienced an uplift of +2.0 cm. Then, in 2021, these two cities will be dominated by an uplift movement of +5.5 cm. Geodynamic equilibrium in this area will occur in 2022. The dominance of subsidence of -13.0 cm causes tectonic movement towards conditions before 2020. George Town and Butterworth experienced land subsidence of -5.5 cm in 2020-2022. Infrastructure development, groundwater consumption, land cover changes, and aquifer dynamics can cause high land subsidence in George Town and Butterworth.

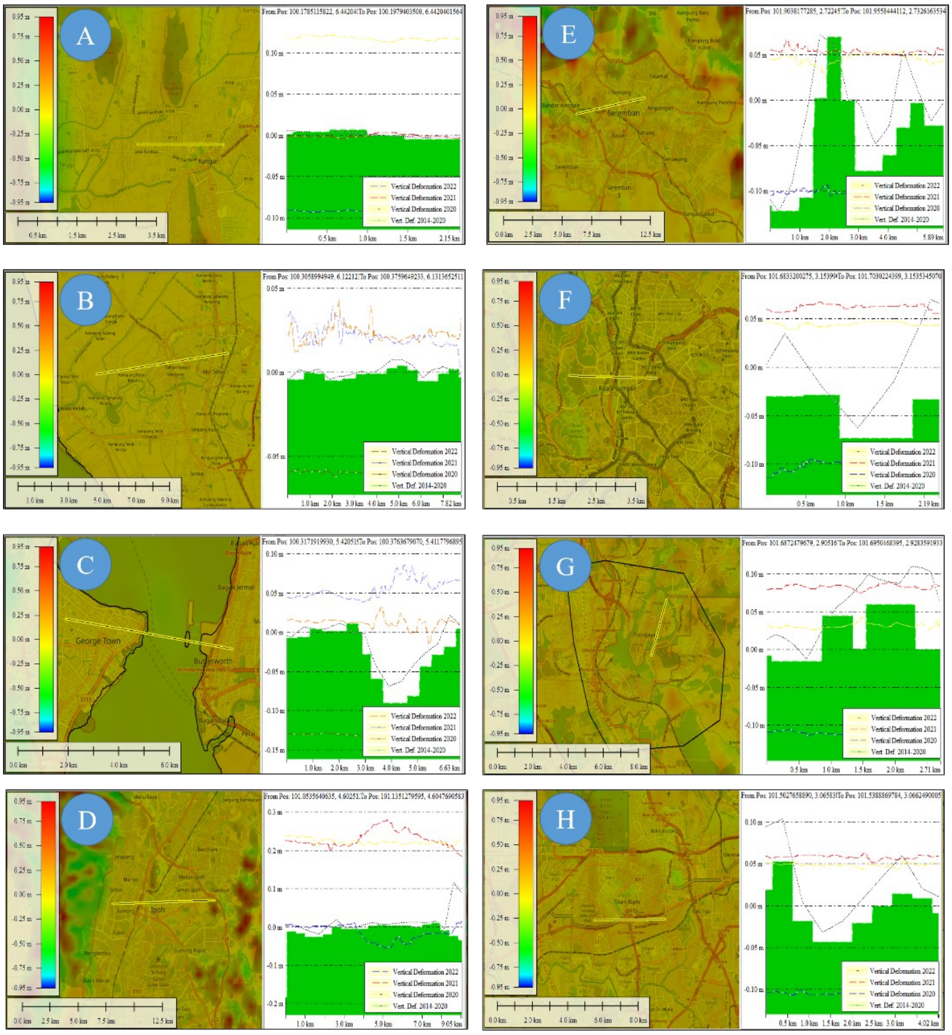


Figure 3: Time-Series Vertical Deformation in the West Coast of Peninsular Malaysia (2014-2022). A. Kangar; B. Alor Setar; C. George Town and Butterworth; D. Ipoh; E. Seremban; F. Kuala Lumpur; G. Putra Jaya; H. Shah Alam

Ipoh is the capital of the state of Perak. It is located in the central part of Peninsular Malaysia or north of Kuala Lumpur. In 2014-2024, Ipoh is dominated by land subsidence with a value of -1.0 cm, see Figure 3(D). Then, in 2020 and 2021, Ipoh will be affected by a global vertical deformation anomaly, which causes an extreme uplift. Another factor that caused the uplift was landslides and significant floods in 2020-2021. The 2020 uplift value is +21.0 cm, and the 2021 uplift value is +22.0 cm. A landslide causes the formation of piles of soil (uplift) with a broader area, but the landslide point causes subsidence in a smaller area. Major floods cause sedimentation and mineral displacement to form new land or increase the thickness of the soil (uplift). In 2022, Ipoh experience a land subsidence of -1.0 cm. Ipoh is a geological area that experiences high dynamics. Uplift and subsidence can occur one after another, depending on natural conditions, and anthropogenic activities. Fault movements cause natural conditions. Anthropogenic activities include excess groundwater extraction, plantation and mining activities, and infrastructure development. Ipoh is dominated by an uplift in 2020-2022.

The Seremban is located on the south side of Kuala Lumpur. It is the capital state of Negeri Sembilan. Seremban is one of the cities affected by subsidence due to the surrounding area experiencing uplift and the use of groundwater, which is quite large. In 2014-2020, Seremban experienced an uplift of -5.0 cm, see Figure 3(E). In 2020, this region will experience subsidence of -10.0 cm. Global vertical deformation anomaly factors groundwater use and infrastructure development can cause high subsidence. Natural equilibrium occurs in 2021 and 2022. In this period, the geodynamic movement is uplifting at +5.0 cm/year. There will be almost no subsidence in 2021-2022 in Seremban. Overall, in 2020-2022, there will be low subsidence and uplift. The vertical position in 2022 is close to the vertical position in 2020. The potential for land subsidence in Seremban is still threatening for the next few years if excessive groundwater use and infrastructure development occur.

Kuala Lumpur is the capital city of Malaysia. This city is located in Peninsular Malaysia. Kuala Lumpur is vulnerable to land subsidence. Based on the results of observations in 2014-2020, Kuala Lumpur is dominated by subsidence with an average value of -5.0 cm, see Figure 3 (F). In 2020, subsidence will reach -10 cm caused by various factors such as global vertical deformation anomaly, infrastructure development, and high groundwater consumption. In 2021 and 2022, uplift will be more dominant compared to subsidence. The uplift value in 2021 is +5.5 cm, and in 2022 it is +5.0 cm. In 2020-2022, the subsidence predominate in Kuala Lumpur at -0.5 to 1.0 cm each year. Groundwater consumption and infrastructure development will be the main factors of future land subsidence in Kuala Lumpur. Consumption of groundwater will be high along with the increase in the number and density of residents in Kuala Lumpur.

Putra Jaya is the capital of the Malaysian government. It is located on the south side of Kuala Lumpur. Before 2020, an uplift of +2.0 cm dominated Putra Jaya, see Figure 3(G). Then, 2020 subsidence will dominate due to the influence of a global vertical deformation anomaly of -10.0 cm. In 2021, Putra Jaya experienced a geodynamic equilibrium with a movement of +7.0 cm. The end of the equilibrium movement will occur in 2022. In 2022, there will be an uplift dominance of +3.0 cm. These conditions have caused Putra Jaya to return to its vertical position as it was before 2020. Putra Jaya is dominated by the uplift of +0.5 to +1.0 cm, and several areas will experience subsidence of -0.5 cm in 2020-2022. Infrastructure development and groundwater consumption are the main factors causing land subsidence in Putra Jaya. The potential for land subsidence in Putra Jaya is still smaller than the potential for land subsidence in Kuala Lumpur.

Shah Alam is located on the west side of Kuala Lumpur. Shah Alam is one of the cities in Malaysia that experienced subsidence in 2014-2020, see Figure 3(H). Shah Alam's subsidence value in that period was -3.5 cm. Infrastructure development and high groundwater consumption are one of the causes of land subsidence in this region. Shah Alam also has many settlements and potentially high population densities. The coastal area also has soft soil and is prone to subsidence. The influence of the global vertical deformation anomaly in 2020 will also have an impact on subsidence in Shah Alam, with a value of -10.0 cm. In 2021 and 2022, an uplift of +5.5 cm and +5.0 cm will be dominated. The uplift conditions during these two years have impacted the geodynamic equilibrium in Shah Alam. The subsidence dominated in Shah Alam for the 2020-2022 period (-1 cm). The potential for land subsidence could increase in the future due to the rapid development of infrastructure in this region and the increasing number and density of the population. Land subsidence in Shah Alam is still in the normal category today.

Malacca is located in the southern part of Kuala Lumpur. Malacca experienced land subsidence of -5.0 cm in 2014-2020, see Figure 4(D). In 2020, a high subsidence of -10.0 cm was observed. The consumption and use of groundwater, relatively unstable soil types, and the effects of global vertical deformation influence this high subsidence value. In 2021, Malacca will be dominated by an uplift of +5.0 cm. Malacca will also be dominated by an uplift of +4.5 cm in 2022. Overall, Malacca is dominated by subsidence in 2020-2022. The subsidence value is -0.5 to -1 cm. The potential for land subsidence in the following years could also threaten Malacca. The value of land subsidence in Malacca is still classified as low to moderate because it is still around 0 to -5.0 cm/year.

(2) East Coast of Peninsular Malaysia

The east coast of Peninsular Malaysia includes Kota Bahru, Kuala Terengganu, and Kuantan. Kota Bahru is located near the Thailand border. Kota Bahru experiences relatively high dynamics of vertical deformation. In 2014-2020, the vertical deformation in this city is more towards subsidence, see Figure 4(A). The average subsidence value in 2014-2020 is -1 cm. This condition is still stable and indicates that subsidence in Kota Bahru is caused by slow tectonic movements and groundwater extraction with a relatively equal amount each year. Groundwater extraction in Kota Bahru may be high in terms of consumption in Malaysia, but it is less extreme than on the northern coast of Java and Africa. A global deformation anomaly occurred in 2020, resulting in higher subsidence in Kota Bahru. The subsidence value in 2020 is -8.5 cm. In 2021, there will be a high uplift of +5.0 cm. This uplift process is part of the tectonic movement to balance the post-anomaly region of global vertical deformation. In 2022, there will be another subsidence of -6.0 cm. This condition can be caused by tectonic movements to balance the geodynamics of the region. It can also be caused by the effect of groundwater withdrawal, which is starting to increase. Kota Bahru has experienced subsidence of -3.2 cm (2020-2022).

Kuala Terengganu is the capital state of Terengganu. It is located at the mouth of the Terengganu River. Kuala Terengganu is one of the cities in Malaysia that has the potential to experience land subsidence. In 2014-2020, subsidence was observed with an average of -3.0 cm, see Figure 4(B). Then, in 2020, Kuala Terengganu was affected by a global vertical deformation anomaly and experienced an uplift of +4.5 cm. In 2021, the geodynamic process to balance the area will be carried out naturally, and this area will experience subsidence of -12.0 cm. The factor of high groundwater withdrawal can also be the cause of the high subsidence rate in 2021. In 2022, Kuala Terengganu will experience an uplift of +4.0 cm. One of the causes of this area experiencing uplift is sedimentation around the river mouth and flooding that occurs in this area. Sedimentation and flooding are more dominant than high groundwater withdrawal, so the uplift effect is more dominant than subsidence in 2022. Kuala Terengganu experienced land subsidence of -4.2 cm in the 2020-2022.

Kuantan is the capital of the state of Pahang. Kuantan is a city vulnerable to land subsidence, see Figure 4(C). In 2014-2020, the subsidence value in Kuantan was -4.0 cm. This condition is higher than in other areas around Pahang. Subsidence in Kuantan is slightly lower than in Johor Bahru, Kuala Terengganu, Kuala Lumpur, Seremban, and Malacca. This quaternary is not too affected by the global vertical deformation anomaly. Land subsidence in Kuantan is dominated by groundwater use and infrastructure development. In 2020, the subsidence value in Kuantan is -1.0 cm. In 2021, Kuantan will also be dominated by subsidence with a value of -0.5 cm. Another condition in 2022, Kuantan, is more dominated by uplift with a value of +2.0 cm. One of the factors causing the uplift in 2022 is caused by the major flood that hit Kuantan. It causes sedimentation and the addition of minerals or soil erosion brought by the flood from upstream. Kuantan is located in the coastal and estuary parts of the river so that the range of sedimentation occurs. In 2022, there will be land subsidence in several areas in Kuantan, but uplift will dominate this area.

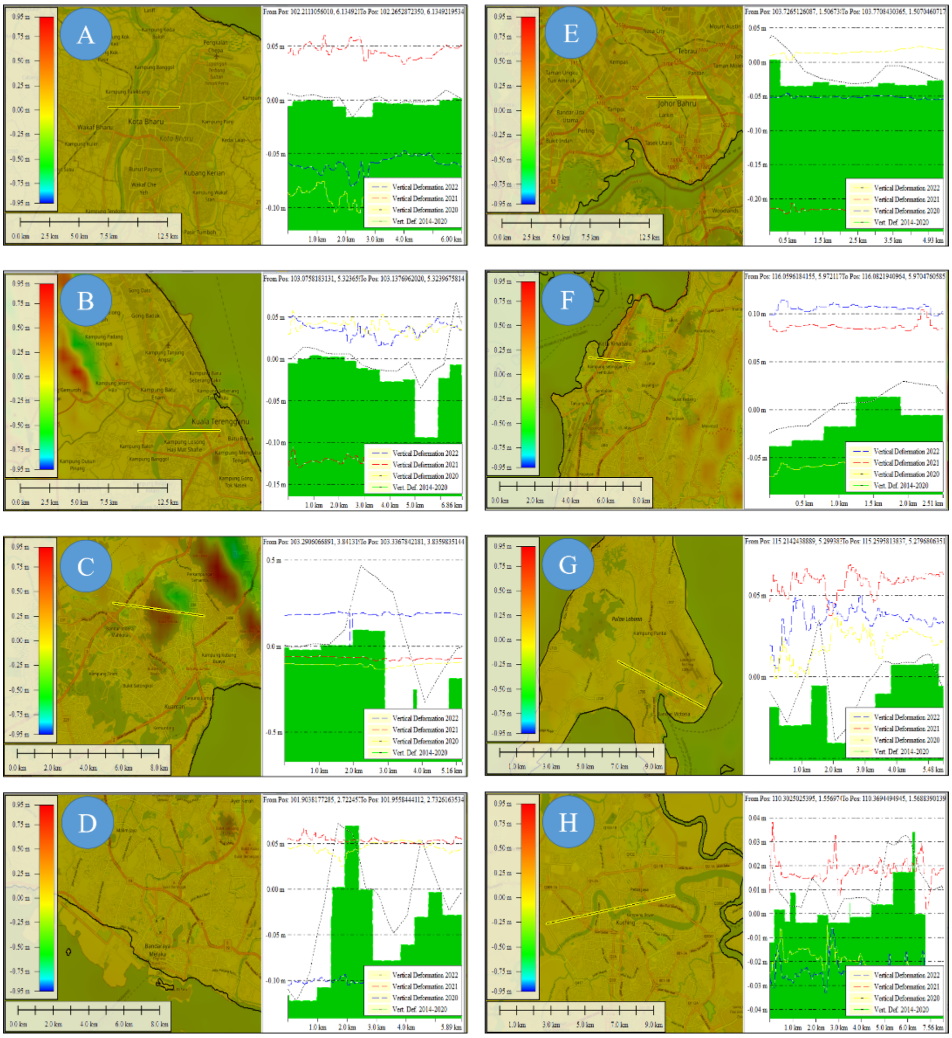


Figure 4: Time-Series Vertical Deformation in Malacca, East Coast of Peninsular Malaysia, East Malaysia (2014-2022). A. Kota Bahru; B. Kuala Terengganu; C. Kuantan; D. Malacca; E. Johor Bahru; F. Kinabalu; G. Bandar Labuan (Victoria); H. Kuching

Johor Bahru is the capital of the state of Johor. Johor Bahru is located on the southern side of Peninsular Malaysia and borders Singapore. Johor Bahru has a high population, making it the second-largest city in Malaysia. This high population number causes the demand for water to be high. Consumption of groundwater is one way to fulfil its needs. Johor Bahru is an area with high land subsidence potential. The city experienced a land subsidence of -4.0 cm in 2014-2020, see Figure 4(E). In 2020, Johor Bahru will also experience subsidence of -5.0 cm. The increase in the potential for land subsidence also impacts other disasters such as major floods, which stagnant water for a long time. This major flood comes from the upstream area and tidal floods at the highest tide. In 2021, a high potential for land subsidence was detected in this region. Some areas reach -21.0 cm. The significant subsidence value was caused by landslides, soil eroded by flood waters, excessive groundwater, drastic changes in topography, or drastic changes in aquifer networks. There were major floods in Johor in 2021. Many factors are causing land subsidence in 2021. In 2022, the Johor Bahru area will be dominated by uplifts. It was caused by a lot of sedimentation and major floods that exceeded 2021. Even though land subsidence will still occur in 2022, the uplift value has become more dominant this year. The uplift value in 2022 is +1.5 cm. Johor Bahru is dominated by land subsidence of -24.5 cm in 2020-2022.

(3) East Malaysia

East Malaysia include Kinabalu, Bandar Labuan (Victoria), and Kuching. Kinabalu is the capital of the state of Sabah. It is located on Borneo Island and the northern coast of East Malaysia. Kinabalu is a coastal area prone to major and tidal floods. Kinabalu is located on soft soil and is prone to potential land subsidence. In 2014-2020, Kinabalu experienced a land subsidence of -3.0 cm, see Figure 4(F). Then 2020, there will also be a subsidence of -5.5 cm. Subsidence will also occur in 2021 and 2022, but uplift will dominate Kinabalu. Significant floods, high sedimentation, and high erosion upstream caused the dominant uplift condition. The major flood in 2021 led to an uplift dominance of +8.0 cm. Likewise, the major floods in 2022 led to an uplift dominance of +10.5 cm. Overall, Kinabalu experienced an uplift of +13.0 cm. The potential for significant floods and sedimentation in the coming years can cause a high uplift, causing the addition of new land on the coast of Kinabalu. Land subsidence will continue, especially in peat areas, swamps, and densely populated settlements.

Bandar Labuan (Victoria) is the capital of the Labuan federal region. It is located adjacent to Kinabalu. Bandar Labuan (Victoria) experienced land subsidence in 2014-2020 with a value of -1.5 cm, see Figure 4(G). However, in 2020-2022, uplift will be more dominant than land subsidence. The increase in uplift value can be caused by sedimentation coming from upstream and accretion from ocean currents that carry mineral sediments. In 2020, the uplift value at

Bandar Labuan (Victoria) was +2.0 cm. In 2021, there will be an additional uplift value of +6.0 cm. In 2023, the uplift value at Bandar Labuan (Victoria) is +3.5 cm, while in 2020-2022, the uplift was +11.3 cm.

Kuching is the capital of the state of Sarawak. It is located on the northern coast of East Malaysia and Borneo Island. Kuching is a lowland city located on the river banks. The soil in Kuching is also classified as soft, unstable, and dominated by peat and swamps. Kuching is an area that has the potential for land subsidence, see Figure 4(H). In 2014-2020, the subsidence value is -0.5 cm. Likewise, in 2020, there has been a subsidence of -2.0 cm. In 2021, uplift is more dominant in Kuching compared to land subsidence. The uplift value is +2.0 cm. One of the causes of the uplift in 2021 is that significant floods will bring lots of minerals and sedimentation. Land subsidence in Kuching is caused more by natural factors and anthropogenic activities. These natural factors are the dynamics of peat and swamp lands. The change in land cover is in the form of forests converted to oil palm plantations so that water absorption becomes less in the upstream part. Land subsidence in 2022 is more dominant in Kuching, with a value of -2.5 cm. It is caused by the dynamics of peat and swamp lands in Kuching, which are more dominant than sedimentation and soil erosion. Kuching is dominated by land subsidence in 2020-2022 with a value of -2.5 cm.

Land Subsidence Dynamics in 16 Cities in Malaysia

The vertical deformation results of the 16 cities have been tested using height different tests. We use 25 height points to create the polygon test in all study areas. All vertical deformation has no blunder error, no systematic error, and minimum random error (less than 1.96σ in a confidence level of 95 %). The result of the height difference test is ~ 0 m. It means that all vertical deformation results are in the same height reference plane and have high precise relative vertical accuracy. Based on the 2014-2022 vertical deformation analysis results, which cities are more vulnerable to land subsidence can be seen, see Table 1. The city most vulnerable to potential land subsidence is Johor Bahru. Then followed by Kuala Terengganu, Seremban, Kuala Lumpur, Shah Alam, Malacca, and Kuantan. The city that has the lowest risk of land subsidence is Kangar. Cities that have a high risk of uplift are Kinabalu and Bandar Labuan (Victoria).

Kota Bahru, George Town and Butterworth, Alor Setar, Ipoh, Putra Jaya, and Kuching are cities with moderate levels of land subsidence and uplift vulnerability. The results of this study can be used for further study of urban planning that is safe from the threat of land subsidence, especially in Johor Bahru, Kuala Terengganu, Seremban, Kuala Lumpur, Shah Alam, Malacca, and Kuantan. Overall, Malaysia's value rate of land subsidence is -0.5 cm to -6.0 cm. The uplift value rate in Malaysia is in the range of +0.5 cm to +4.5 cm. According to research (Yong et al., 2018), the northern Kelantan subsides at a maximum rate of 4.22 ± 0.17 mm/year (1σ confidence level). It shows higher ground deformation rates than the other parts of Peninsular Malaysia (0.22 ppm/year). This condition is similar to the results from the D-InSAR that the Kota Bahru area has experienced subsidence of -3.2 cm in 2020-2022. Although the study location in Kelantan is slightly different, it still has similarities in regional tectonic movements.

Table 1: The Vertical Deformation in 16 Cities of Malaysia during 2014-2022

No	City Name	Mean of Vertical Deformation 2022 (cm)	Mean of Vertical Deformation 2021 (cm)	Mean of Vertical Deformation 2020 (cm)	Mean of Vertical Deformation 2014-2020 (cm)
1.	Kota Bahru	-6.0	+5.0	-8.5	-1.0
2.	Kuala Terengganu	+4.0	-12.0	+4.5	-3.0
3.	George Town and Butterworth	-13.0	+5.5	+2.0	-2.0
4.	Alor Setar	-7.0	+3.0	+3.5	-0.5
5.	Kangar	-9.0	-0.5	+10.0	-0.5
6.	Ipoh	-1.0	+22.0	+21.0	-0.5
7.	Seremban	+5.0	+5.0	-10.0	-5.0
8.	Malacca	+4.5	+5.0	-10.0	-5.0
9.	Kuala Lumpur	+5.0	+5.5	-10.0	-5.0
10.	Putra Jaya	+3.0	+7.0	-10.0	+2.0
11.	Shah Alam	+5.0	+5.5	-11.0	-3.5
12.	Kuantan	+2.0	-0.5	-1.0	-4.0
13.	Johor Bahru	+1.5	-21.0	-5.0	-4.0
14.	Kinabalu	+10.5	+8.0	-5.5	-3.0
15.	Bandar Labuan (Victoria)	+3.5	+6.0	+2.0	-1.5
16.	Kuching	-2.5	+2.0	-2.0	-0.5

Value (+) = uplift; value (-) = land subsidence

Research by Gao et al., 2021 concluded that Pulau Pinang experienced an indication of land subsidence that would increase 2.0% and 5.9% of the inundated area based on the different scenarios by 2100 projections. In this study, George Town and Butterworth experienced land subsidence of -5.5 cm in 2020-2022. Land subsidence in this city has increased compared to the 2014-2020 period. One way to minimise land subsidence is by regulating groundwater use, building balanced infrastructure, minimising tunnels, mining and plantations, and monitoring groundwater aquifer networks. Regional and urban development needs to apply disaster mitigation-based planning such as land subsidence, sedimentation, land erosion, abrasion, and coastal accretion. The D-InSAR method on Sentinel-1 (free data) can be used widely (area), efficiently (mapping costs), and effectively (work time) to monitor large areas and time series.

CONCLUSION

The land subsidence dynamics of 16 cities in Malaysia were monitored by collecting time-series vertical deformation data between 2014-2022. We use Sentinel-1 imagery data and a modified D-InSAR method for extracting the vertical deformation. The results of the vertical deformation analysis 2014-2022 were used to identify the cities that were most vulnerable to land subsidence and uplift. The city that has the lowest risk of land subsidence is Kangar, while the city most vulnerable to potential land subsidence is Johor Bahru. The other cities vulnerable to land subsidence are Kuala Terengganu, Seremban, Kuala Lumpur, Shah Alam, Malacca, and Kuantan. Kota Bahru, George Town and Butterworth, Alor Setar, Ipoh, Putra Jaya, and Kuching are cities with moderate levels of land subsidence and uplift vulnerability. The cities that are vulnerable to uplift are Kinabalu and Bandar Labuan (Victoria). Malaysia's value rate of land subsidence is between -0.5 cm to -6.0 cm, while the uplift value rate in Malaysia is between +0.5 cm to +4.5 cm.

ACKNOWLEDGEMENT

I want to thank the BRIN for supporting this independent research and also a special thanks to the anonymous reviewers and the editor of the Planning Malaysia journal. The author is the main contributor to this paper.

REFERENCES

Ardha, M., Suhadha, A. G., Julzarika, A., & Yudhatama, D. (2021). Utilization of Sentinel-1 satellite imagery data to support land subsidence analysis in DKI Jakarta, Indonesia. *J. Degrade. Min. Land Manage*, *8*(2), 2587–2593. https://doi.org/10.15243/jdmlm.2021.082.2587

Devanthéry, N., Crosetto, M., Cuevas-González, M., Monserrat, O., Barra, A., & Crippa, B. (2016). Deformation Monitoring Using Persistent Scatterer Interferometry and Sentinel-1 SAR Data. *Procedia Computer Science*, *100*, 1121–1126. https://doi.org/10.1016/j.procs.2016.09.263

ESA. (2019). *Sentinel Satellites*. European Space Agency. https://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Overview4

Ferretti, A., Guarnieri, A. M., Prati, C., & Rocca, F. (2007). InSAR Principles: Guidelines for SAR Interferometry Processing and Interpretation. In K. Fletcher (Ed.), *Proceedings of the National Academy of Sciences of the United States of America*. European Space Agency, ESA Publication ESTEC Postbus 299 220 AG Noordwijk The Netherlands.

Julzarika, A., Aditya, T., Subaryono, S., & Harintaka, H. (2021). The latest dtm using InSAR for dynamics detection of Semangko fault-indonesia. *Geodesy and Cartography (Vilnius)*, *47*(3), 118–130. https://doi.org/10.3846/gac.2021.12621

Julzarika, A., Aditya, T., Subaryono, S., & Harintaka, H. (2022). Dynamics Topography Monitoring in Peatland Using the Latest Digital Terrain Model. *Journal of Applied Engineering Science*, *20*(1), 246–253. https://doi.org/10.5937/jaes0-31522

Mohamed, A., & Gonçalvès, J. (2021). Hydro-geophysical monitoring of the North Western Sahara Aquifer System's groundwater resources using gravity data. *Journal of African Earth Sciences*, *178*(March). https://doi.org/10.1016/j.jafrearsci.2021.104188

Motagh, M., Shamshiri, R., Haghshenas Haghighi, M., Wetzel, H. U., Akbari, B., Nahavandchi, H., Roessner, S., & Arabi, S. (2017). Quantifying groundwater exploitation induced subsidence in the Rafsanjan plain, southeastern Iran, using InSAR time-series and in situ measurements. *Engineering Geology*, *218*. https://doi.org/10.1016/j.enggeo.2017.01.011

Muhammad, S. B., Abubakar, S., Abir, I. A., & Mohammed, A. (2021). Land Subsidence Studies of Seberang Perai Malaysia, By Integrating Remote Sensing Technique and Resistivity Survey Method. *IOSR Journal of Applied Geology and Geophysics*, *8*(1), 41–47. https://doi.org/10.9790/0990-0801034147

Rucci, A., Ferretti, A., Monti Guarnieri, A., & Rocca, F. (2012). Sentinel 1 SAR interferometry applications: The outlook for sub millimeter measurements. *Remote Sensing of Environment*, *120*, 156–163. https://doi.org/10.1016/j.rse.2011.09.030

Stampoulis, D., Reager, J. T., David, C. H., Andreadis, K. M., Famiglietti, J. S., Farr, T. G., Trangsrud, A. R., Basilio, R. R., Sabo, J. L., Osterman, G. B., Lundgren, P. R., & Liu, Z. (2019). Model-data fusion of hydrologic simulations and GRACE terrestrial water storage observations to estimate changes in water table depth. *Advances in Water Resources*, *128*(November 2018), 13–27. https://doi.org/10.1016/j.advwatres.2019.04.004

Suhadha, A. G., & Julzarika, A. (2022). Dynamic Displacement using DInSAR of Sentinel-1 in Sunda Strait. *Trends in Sciences*, *19*(13), 4623. https://doi.org/10.48048/tis.2022.4623

Suhadha, A. G., Julzarika, A., Ardha, M., & Chusnayah, F. (2021). Monitoring Vertical Deformations of the Coastal City of Palu after Earthquake 2018 Using Parallel-SBAS. *Proceedings - 2021 7th Asia-Pacific Conference on Synthetic Aperture Radar, APSAR 2021*, *March*. https://doi.org/10.1109/APSAR52370.2021.9688380

Suratman, S. (2012). Groundwater-What and Why? *Conference Groundwater-What, Why, Where and How?,*.

Zhu, L., Gong, H., Li, X., Wang, R., Chen, B., Dai, Z., & Teatini, P. (2015). Land subsidence due to groundwater withdrawal in the northern Beijing plain, China. *Engineering Geology*, *193*. https://doi.org/10.1016/j.enggeo.2015.04.020

Received: 8th April 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 341 – 356

FENG SHUI SUPERSTITIOUS BELIEF: DOES IT INFLUENCE YOUNG GENERATIONS IN HOUSING PURCHASE INTENTION?

Mohammad Mujaheed Hassan[1], Peter Aning Tedong[2], Asmaul Husna Haris Fadzilah[3]

[1] *Faculty of Human Ecology,*
[1] *Malaysian Research Institute on Ageing (MyAgeing™),*
UNIVERSITI PUTRA MALAYSIA
[2] *Faculty of Built Environment,*
UNIVERSITI MALAYA
[3] *Faculty of Economics and Business,*
UNIVERSITI MALAYSIA SARAWAK

Abstract

Superstition is an indispensable part of every ethnic culture in Malaysia. Each race has its own culture and its own superstitions. This is certainly true in the multicultural landscape of Malaysia. Since superstition is part of daily life, it can even have an impact on the housing property market. This article aims to examine the superstitious beliefs in *Feng Shui* of the young generation's intention to buy a house. This study focuses on the young generation with the prime working-aged between 25 and 40 years old in the Klang Valley. This study uses quantitative methods. A total of 2,600 questionnaires were distributed, however, only 97% or 2523 questionnaires are valid to proceed for data analysis. In summary, there is a significant correlation between the influences of superstition beliefs on the willingness of a young one to buy a house. Superstition is affecting the decision-making process of the Chinese community.

Keywords: superstition, belief, housing property, *Feng Shui*

[1] Corresponding Author. Email: mujaheed@upm.edu.my

INTRODUCTION

Superstitious beliefs, characterized by the erroneous establishment of causality, occasionally lead to irrational behaviour (Foster & Kokko, 2009). Malaysians continue to uphold superstitions passed down through generations, attributing their persistence to ancestral legacies (Alias et al., 2014). For instance, Malays caution against bringing umbrellas indoors, believing it brings bad luck. This practice stems from practical concerns like wet floors and accidental pokes, although the superstition remains prevalent. Similarly, traditional Chinese families refrain from house chores on the first day of the Lunar New Year, as sweeping is thought to remove good fortune. This tradition reflects the desire for a respite after a year of hard work, symbolizing avoidance of hardships (Hui et al., 2019). Indian families, on the other hand, believe stepping over books makes one stupid, even though logic suggests otherwise. Books represent knowledge, making it impolite to disrespect them. Moreover, superstitions significantly impact beliefs in supernatural phenomena, influencing supply and demand in specific industry markets. In Malaysia, ethnic groups, including Malays, Chinese, and Indians, exhibit diverse cultural opinions when purchasing houses (Tedong et al., 2018). Demographic factors, such as race, significantly shape real estate market dynamics (San, 2016). In housing property markets worldwide, superstitious beliefs, particularly Feng Shui, influence homebuyers' decision-making processes, impacting property orientation, layout, and surroundings (Walters, 1988). *Feng Shui* is believed to enhance luck in various aspects of life, including career, wealth, relationships, health, and travel. Chinese superstitious beliefs strongly affect house prices, with properties deemed "good" in *Feng Shui* commanding higher market prices, leading to construction based on *Feng Shui* principles (Hui et al., 2019; Fortin et al., 2014). Despite the absence of scientific evidence linking superstition to positive or negative events in housing, these practices persist due to cultural traditions (Hui et al., 2019).

LITERATURE REVIEW

This paper extensively investigates the impact of *Feng Shui*, superstitions, and cultural beliefs on housing purchase decisions, drawing insights from studies by Liang et al. (2015), Chia et al. (2016), Sia et al. (2018), and Hui et al. (2019). It delves into how factors like unfavourable *Feng Shui* locations, proximity to cemeteries, house numbers, and superstitious beliefs influence the real estate market and consumer choices. The research underscores the significance of these elements in shaping consumer preferences, underscoring the necessity for developers to acknowledge cultural sensitivities when targeting specific demographics. This comprehensive review adds to the existing body of knowledge in housing studies and provides valuable insights for real estate professionals, researchers, and policymakers. The paper highlights the complexity of house purchase decisions, influenced by a multitude of factors, including location, design, cultural beliefs, and superstitions. *Feng Shui*, deeply rooted in Chinese tradition, significantly influences the preferences and decisions of potential homebuyers. It scrutinizes the impact of *Feng Shui*, superstitions, and cultural beliefs on the housing market, with specific attention to unfavourable *Feng Shui* locations and their implications for future investments. Notably, favourable *Feng Shui* locations are found to attract potential buyers, with crucial considerations including land topography, interior design, and the number of doors. The presence of poor *Feng Shui*, particularly in homes near or facing cemeteries, can significantly affect future investment prospects, leading to lower resale prices. Certain house numbers in Chinese culture carry symbolic meanings, such as the negative connotation of the number four and the auspiciousness of the number three.

The paper by Chia et al. (2016) establishes correlations between the number of superstitions and the willingness to buy a house, though the impact on actual house purchase intention is nonsignificant. The study also reveals that beliefs in supernatural phenomena, such as ghosts, do not significantly influence purchasing behaviour due to a lack of belief in such phenomena. Moreover, respondents in the study by Sia et al. (2018) express preferences for specific house features related to *Feng Shui*, including a strong wooden front door, well-lit living rooms, and desirable views, while unfavourable architectural and interior elements are identified. Lastly, Hui et al. (2019) finds that superstitious beliefs, while not significantly impacting purchasing intentions overall, persist among the younger generation, shaping their actions and behaviours. Developers targeting the Chinese community must be mindful of these beliefs to avoid negative associations with their property projects. In summary, this paper provides a comprehensive review of how *Feng Shui*, superstitions, and cultural beliefs influence housing purchase decisions. Understanding these factors can help professionals in the real estate industry, researchers, and policymakers make informed decisions and strategies to cater to the diverse preferences of potential homebuyers. Further research in this domain can enhance our understanding of cultural dynamics and their implications for the housing market.

Hypotheses

Two null hypotheses have been developed in this research study, which are: -

Ho1	:	There is no significant correlation between superstitious beliefs influencing the young generation in housing purchase intention.
Ho2	:	There is no significant difference in superstitious beliefs of the young generation on by races in housing purchase intention.

RESEARCH METHODOLOGY

This study targets individuals aged 25 to 40 in the Klang Valley, Malaysia, using quantitative methods. About 2,600 questionnaires were distributed, employing convenience and snowball sampling. Respondents completed self-administered questionnaires, resulting in 2,523 valid responses. Data analysis employed SPSS software, utilizing Cronbach's Alpha Coefficient, Descriptive Analysis, and Inferential Statistics like T-Test and ANOVA.

Variables Reliability Test and Descriptive Analysis

Cronbach's Alpha was used to assess internal consistency. The values ranged from 0.690 to 0.873, indicating acceptable to good reliability (Neo et al., 2017; Flynn et al., 1994).

Table 1.0: Variables Reliability Test and Descriptive Analysis

Variable	Item Indicator	Cronbach's Alpha Value	Range	Min	Max	Mean	Std. Deviation
SUPERSTITOUS BELIEF	SB	.933	4.00	1.00	5.00	3.8182	1.03265
House History	HH	.757	4.00	1.00	5.00	4.0095	1.18170
House Number	HN	.805	4.00	1.00	5.00	3.4356	1.39335
House Location	HL	.808	4.00	1.00	5.00	3.5180	1.33992
House View	HV	.793	4.00	1.00	5.00	3.9596	1.23777
House Direction	HD	.856	4.00	1.00	5.00	3.5894	1.34857
Neighbourhood	N	.814	4.00	1.00	5.00	4.0155	1.03668
Dwelling Features	DF	.690	4.00	1.00	5.00	4.2002	.95662
PURCHASE INTENTION	PI	.873	4.00	1.00	5.00	4.0317	.84093

RESULT AND DISCUSSION

Respondents Demographic Background

The respondent's demographic background based on race is summarized and presented in Table 2.0, 44.3% (1117) Malay, 33.8% (852) Chinese, 16.8% (425) Indian, and 5.1% (129) belong to other races.

Table 2.0: Demographic Background of the Respondents

Variable		Frequency	Percentage
Race	Malay	1117	44.3
	Chinese	852	33.8
	Indian	425	16.8
	Others	129	5.1
	TOTAL	2523	100.00

Intention to Purchase Housing Property

Purchase intention, as defined by Wu and Teng (2011) and Ajzen (1991), refers to a customer's plan to buy a product or service in the future, influenced by motivational factors and indicating the likelihood of performing that behaviour. In the context of this study, "willingness to buy a house" signifies consumers' readiness to purchase a house in the near future, aligning with Ajzen's definition. Table 3.0 reveals a high mean score (4.1513) for the intention to own a housing property, contrasting with a low mean score (2.2104) for having no intention to own one. Analysing the data in Table 3.1, it becomes apparent that 43.9% of respondents have a high intention to own a house, 55.1% hold a moderate intention, and only 1.0% possess a low intention. Overall, the mean score (3.6202) suggests a moderate level of intention to purchase among the young generation in Klang Valley. Furthermore, both mean scores for housing purchase intention, whether for personal living or investment, are notably high (4.1075 and 4.2677, respectively). Table 3.1 indicates that 87.8% of respondents intend to buy a house for investment purposes, while 12.2% plan to purchase one for their personal living. These findings indicate a strong inclination among the young generation in Klang Valley to invest in housing properties.

Table 3.0: Housing Purchase Intention Descriptive Analysis

Variable	Mean	SD	Min	Max
Intention to own housing property	4.1513	.89381	1.00	5.00
I have an intention to buy a house	4.2335	.88773		
I have thought of buying a house	4.2061	.92004		
I plan to buy a house	4.0143	1.09129		
No intention to own housing property	2.2104	.93094	1.00	5.00
I prefer to rent a house	2.1407	1.12203		
I do not have to buy a house	2.0824	1.11419		
I will live in my parents' house	2.4082	1.23064		
Owning for living	4.1075	.83267	1.00	5.00
I want to buy/ bought a house to live in	4.1352	.92092		
I want to buy/ bought a house because I need a place to live	4.0721	1.01121		
I want to buy/ bought a house because I don't like to rent	4.1153	.96887		
Investment	4.2677	.87517	1.00	5.00
I want to buy/ bought a house for investment	4.1514	1.27069		
I want to buy/ bought a house as an assets	4.3853	.79639		
I want to buy/ bought a house for rent as a side income	4.2663	.90925		

Table 3.1: The Level of Housing Purchase Intention

Variable	n	%	Mean	SD	Min	Max
Level of Intention to Purchase			3.6202	.60746	1.88	4.50
High (3.63-4.50)	1108	43.9				
Moderate (2.76-3.62)	1390	55.1				
Low (1.88-2.75)	25	1.0				
Level of Owning for Living			4.1075	.83267	1.00	5.00
High (3.67-5.00)	1952	77.4				
Moderate (2.34-3.66)	476	18.9				
Low (1.00-2.33)	93	3.7				
Level Investment			4.2677	.87517	1.00	5.00
High (3.67-5.00)	2098	83.2				
Moderate (2.34-3.66)	345	13.7				
Low (1.00-2.33)	80	3.2				
The Intention of Purchase			3.0776	.38683	1.00	4.50
Investment (2.76-4.50)	2214	87.8				
Owning (1.00-2.75)	309	12.2				

Correlation Coefficient Analysis

Table 4.0 shows that there is a very weak positive significant correlation between Superstitious Belief (SB) with Purchase Intention (PI) 0.071 overall. The significant level for each aspect is between 0.055 and 0.125.

Table 4.0: Pearson Correlation Coefficient

	HH	HN	HL	HV	HD	N	DF	SB	HPI
HH	1	.587**	.595**	.815**	.621**	.724**	.770**	.795**	.055**
HN		1	.836**	.595**	.868**	.710**	.505**	.902**	.061**
HL			1	.592**	.847**	.689**	.542**	.885**	.041**
HV				1	.676**	.741**	.794**	.808**	.125**
HD					1	.764*	.596**	.925**	.076**
N						1	.777**	.870**	.058**
DF							1	.738**	.083**
SB								1	.071**
PI									1

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

Linear Regression Analysis

The R-value 0.100 in Table 5.0 indicates a very weak positive degree of correlation with the R^2 value 1.0% variation in the dependent variable. Table 5.1 Anova[a] of Linear Regression analysis indicates that the regression model predicts the dependent variable is significant $p < 0.000$, which is less than 0.05. Therefore, Housing Purchase Intentions = 3.721 + 0.100 (Superstitious Belief).

Table 5.0: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of The Estimate
1	.100[a]	.010	.010	.83689

a. Predictors: (Constant), Superstitious Belief

Table 5.1: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig
1	Regression	17.805	1	17.805	25.422	.000[b]
	Residual	1765.658	2521	.700		
	Total	1783.463	2522			

a. Dependent Variable: Housing Purchase Intention
b. Predictors: (constant), Superstitious Belief

Table 5.2: Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.721	.064		58..296	.000
	Superstitious Belief	.081	.016	.100	5.042	.000

a. Dependent Variable: Housing Purchase Intention

Superstitious Belief

1. House History

Table 6.0 reveals that 70.6% of respondents strongly believe in the superstitions related to the history of a house when considering housing purchases. This belief is significant, as indicated by a one-way ANOVA in Table 6.1, which examines the effect of race on these superstitious beliefs. The results show that race does indeed have a significant impact on the belief in house history's role in housing purchase decisions (F=67.712, p=0.000). nPost hoc comparisons using the Tukey HSD test in Table 6.2 demonstrate that the mean belief scores vary significantly among different racial groups: Chinese (M=4.42), Indian (M=4.00), Malay (M=3.75), and others (M=3.44). Specifically, Chinese potential homebuyers show considerable concern regarding a house's history when making their housing purchase decisions. This concern stems from beliefs that vacant or creepy-looking properties might have witnessed unnatural deaths, leading to the lingering presence of spirits. Furthermore, some residential units constructed on the sites of old hospitals or religious locations are avoided due to fears of concentrated spirits. Chinese superstitions also dictate avoidance of homes associated with untimely or abnormal deaths, as they are believed to bring bad luck to careers, health, and businesses.

Table 6.0: Superstitious Belief in House History Descriptive Analysis

Variable	n	%	Mean	SD	Min	Max
House History			4.0095	1.18170	1.00	5.00
High (3.67-5.00)	1781	70.6				
Moderate (2.34-3.66)	256	40.1				
Low (1.00-2.33)	486	19.3				

Table 6.1: One-way ANOVA table for Superstitious Belief in House History by Races Influence Housing Purchase Intention of Young Generation Homebuyers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	262.806	3	87.602	67.712	.000
Within Groups	3258.965	2519	1.294		
Total	3521.772	2522			

Table 6.2: Tukey HSD for Superstitious Belief in House History

Race	N	Subset for alpha = 0.05				SD	Std. Error
		1	2	3	4		
Others	129	3.4496				.62452	.05499
Malay	1117		3.7556			1.18170	.02353
Indian	425			4.0047		1.03019	.04997
Chinese	852				4.4296	.74378	.02548
Sig./Total		1.000	1.000	1.000	1.000	1.18170	.02353

2. House Number

Table 7.0 illustrates that 52.0% of respondents strongly believe in the superstitions related to house numbers, with a mean score of 3.4356. A one-way ANOVA was conducted to assess how different races perceive the superstitions associated with house numbers concerning their impact on housing purchase intentions. The results in Table 7.1 reveal that race significantly affects these superstitions, with a notable F-statistic (493.663) and a p-value of 0.000. Post hoc comparisons using the Tukey HSD test, as presented in Table 7.2, further demonstrate that the mean scores for different races—Chinese (M=4.39), Indian (M=3.92), others (M=3.32), and Malay (M=2.52)—are significantly different. In essence, these findings suggest that superstitions related to house numbers indeed influence housing purchase intentions, with Chinese potential homebuyers displaying a heightened concern for the number associated with a house. Chinese culture attaches various symbolic meanings to numbers, perceiving some as lucky and others as ominous. For instance, numbers like six and nine are regarded as fortunate, while eight is considered the most auspicious due to its phonetic similarity to the word for "fortune." Conversely, the number four is deemed unlucky because it sounds similar to the word for "death," leading many to avoid it.14 is pronounced as '*Sap Sei'* which closely sounds like *'Sat Sei'*, translating to *'Sure to Die'*. 24 is pronounced *'Yi Sap Sei'* and could very much sound like *'Easy to Die'* (Yau 2015; Hui et al., 2019*)*. Though, the Malay community in Malaysia tell a different story as the number 4, in Malay is '*Empat*' which sounds like '*Dapat'*, meaning gain or receive. Some even tell tales of how the number 4 looks like a person sitting cross-legged, looking as carefree as a human can be.

Table 7.0: Superstitious Belief in House Number Descriptive Analysis

Variable	n	%	Mean	SD	Min	Max
House Number			3.4356	1.39335	1.00	5.00
High (3.67-5.00)	1312	52.0				
Moderate (2.34-3.66)	634	25.1				
Low (1.00-2.33)	577	22.9				

Table 7.1: One-way ANOVA table for Superstitious Belief in House Number by Races Influence Housing Purchase Intention of Young Generation Homebuyers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1812.840	3	604.280	493.663	.000
Within Groups	3083.444	2519	1.224		
Total	4896.284	2522			

Table 7.2: Tukey HSD for Superstitious Belief in House Number

Race	N	Subset for alpha = 0.05				SD	Std. Error
		1	2	3	4		
Malay	1117	2.5282				1.35875	.04065
Others	129		3.3256			.65147	.05736
Indian	425			3.9224		1.04660	.05077
Chinese	852				4.3991	.76982	.02637
Sig./Total		1.000	1.000	1.000	1.000	1.39335	.02774

3. House Location

Table 8.0 indicates that 55.4% of the respondents strongly believe in superstitious beliefs related to the location of a house when considering housing purchases, with a mean score of 3.5180. To investigate how race influences these superstitious beliefs and their impact on housing purchase decisions, a one-way ANOVA was conducted, as presented in Table 8.1. The analysis demonstrates a significant effect of race on these beliefs (F=397.266, p=0.000). Post hoc comparisons using the Tukey HSD test in Table 8.2 reveal significant differences in mean belief scores among different racial groups: Chinese (M=4.35), Indian (M=3.94), others (M=3.40), and Malay (M=2.70). These findings suggest that superstitious beliefs about the location of a house indeed influence housing purchase decisions. Specifically, the results indicate that Chinese potential homebuyers place significant importance on the house's location in their housing purchase decisions. In Malaysia, various communities avoid houses built on sloped terrain with the access road sloping downward toward the frontage road, believing it can cause a loss of wealth and luck. *Feng Shui* principles also discourage homes located at the end of T-intersections or on long straight roads, as it disrupts the natural flow of "*chi*" and can lead to negative energy. Homes below street level are avoided due to their potential to create relationship tensions. The ideal location, according to *Feng Shui*, is one surrounded by hills, backed by mountains, and with open space in front, often near a lake or river with flowing water. These beliefs highlight the cultural and superstitious considerations in housing choices in Malaysia.

Table 8.0: Superstitious Belief in House Location Descriptive Analysis

Variable	n	%	Mean	SD	Min	Max
House Location			3.5180	1.33992	1.00	5.00
High (3.67-5.00)	1398	55.4				
Moderate (2.34-3.66)	642	25.4				
Low (1.00-2.33)	483	19.1				

Table 8.1: One way ANOVA table for Superstitious Belief in House Location by Races Influence Housing Purchase Intention of Young Generation Homebuyers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1454.136	3	484.712	397.226	.000
Within Groups	3073.793	2519	1.220		
Total	4527.959	2522			

Table 8.2: Tukey HSD for Superstitious Belief of House Location

Race	N	Subset for alpha = 0.05				SD	Std. Error
		1	2	3	4		
Malay	1117	2.7073				1.36366	.04080
Others	129		3.4031			.61896	.05450
Indian	425			3.9459		1.02072	.04951
Chinese	852				4.3850	.77241	.02646
Sig.		1.000	1.000	1.000	1.000	1.33992	.02668

4. House View

Table 9.0 shows 69.4% of the respondents highly belief in superstitious of the house view with a mean of 3.9596. A one-way ANOVA was conducted to compare the effect of race on the superstitious belief of house view in housing purchase intention. An analysis of variance in Table 9.1 shows that the effect of race on the superstitious belief of house view in housing purchase decision was significant, F (3, 2519 = 109.441, p = 0.000). Post hoc comparison using the Tukey HSD test as shown in Table 9.2 indicate that the mean score for Chinese (M=4.43, SD=0.74), Indian (M=3.97, SD=1.04), Malay (M=3.65, SD=1.51) and others (M=3.44, SD=0.62) was significantly different. However, the mean for Malay and others race are in the same group, this indicates that there are no significant different between these two races. Therefore, these results suggest that superstitious beliefs of house view do influence housing purchase decision. Specifically, result shows that based on race, Chinese potential homebuyers did concern and considered the view of the house in their housing purchase decision. Having cemeteries as a view can be an unpleasant sight. Most local communities dislike staying near cemeteries, hospitals, and religious sites for fear of '*Ying Qi*' or negative energy. The older Chinese folk also warn against staying in high-rise buildings that face curved elevated highways as the curve of the highway resembles a sickle. This is considered a very inauspicious omen towards the owner's health and wealth. The Indian community on the other hand looks for properties with views of water bodies, though it has to be in the right direction. According to the traditional Hindu system of architecture called '*Vastu Shastra'*, water is a huge energy generator. It can bring in very strong positive and negative energies depending on which direction it is located in.

Table 9.0: Superstitious Belief in House View Descriptive Analysis

Variable	n	%	Mean	SD	Min	Max
House View			3.9596	1.23777	1.00	5.00
High (3.67-5.00)	1752	69.4				
Moderate (2.34-3.66)	461	18.3				
Low (1.00-2.33)	310	12.3				

Table 9.1: One-way ANOVA table for Superstitious Belief in House View by Races Influence Housing Purchase Intention of Young Generation Homebuyers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	328.323	3	109.441	77.974	.000
Within Groups	3535.554	2519	1.404		
Total	3863.876	2522			

Table 9.2: Tukey HSD for Superstitious Belief in House View

Race	N	Subset for alpha = 0.05				SD	Std. Error
		1	2	3	4		
Others	129	3.4496				3.4496	0.62452
Malay	1117	3.6535				3.6535	1.51247
Indian	425		3.9718			3.9718	1.04347
Chinese	852			4.4319		4.4319	0.74399
Sig.		.122	1.000	1.000		3.9596	1.23777

5. House Direction

Table 10.0 reveals that 57.3% of respondents strongly believe in superstitious beliefs related to the direction of the house when considering housing purchases, with an average score of 3.5894. To assess the influence of race on these superstitious beliefs regarding house direction and their impact on housing purchase decisions, a one-way ANOVA was conducted, as presented in Table 10.1. The analysis indicates a significant effect of race on these beliefs (F=406.694, p=0.000). Post hoc comparisons using the Tukey HSD test in Table 10.2 demonstrate significant differences in mean belief scores among different racial groups: Chinese (M=4.40), Indian (M=3.93), Malay (M=3.41), and others (M=2.85). These results suggest that superstitious beliefs about the direction of the house indeed influence housing purchase decisions. Specifically, the findings show that Chinese potential homebuyers place significant importance on the orientation of the house in their housing purchase decisions. The Indian community tends to avoid main doors facing South-West due to their belief that it's a direction through which negative forces can enter. Conversely, the Chinese community avoids houses facing the direction of sunrise or sunset to maintain cooler indoor temperatures. Muslims consider the *Qibla*, the direction faced during prayer towards the Kaaba in Mecca, when choosing the orientation of their homes and rooms for religious purposes.

Table 10.0: Superstitious Belief in House Direction Descriptive Analysis

Variable	n	%	Mean	SD	Min	Max
House Direction			3.5894	1.34857	1.00	5.00
High (3.67-5.00)	1443	57.3				
Moderate (2.34-3.66)	609	24.1				
Low (1.00-2.33)	471	18.7				

Table 10.1: One way ANOVA table for Superstitious Belief in House Direction by Races Influence Housing Purchase Intention of Young Generation Homebuyers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1220.082	3	406.694	304.310	.000
Within Groups	3366.513	2519	1.336		
Total	4586.595	2522			

Table 10.2: Tukey HSD for Superstitious Belief in House Direction

Race	N	Subset for alpha = 0.05				SD	Std. Error
		1	2	3	4		
Malay	1117	2.8559				2.8559	1.46212
Others	129		3.4186			3.4186	.58226
Indian	425			3.9388		3.9388	1.03296
Chinese	852				4.4026	4.4026	.75486
Sig.		1.000	1.000	1.000	1.000	3.5894	1.34857

6. Neighborhood

Table 11.0 indicates that 67.7% of respondents strongly believe in superstitions related to the neighbourhood when considering housing purchases, with an average score of 4.0155. A one-way ANOVA, as presented in Table 11.1, was conducted to assess how race influences these superstitious beliefs regarding the neighbourhood and their impact on housing purchase decisions. The analysis shows a significant effect of race on these beliefs (F=80.230, p=0.000). Post hoc comparisons using the Tukey HSD test in Table 11.2 illustrate that mean belief scores significantly differ among different racial groups: Chinese (M=4.41), Indian (M=3.97), Malay (M=3.79), and others (M=3.42). However, the means for the Malay and Indian races are in the same group, indicating no significant difference between these two races. These findings suggest that superstitious beliefs about the neighbourhood indeed influence housing purchase decisions. Specifically, Chinese potential homebuyers place significant importance on the neighbourhood of the housing area when making their housing purchase decisions.

Table 11.0: Superstitious Belief of Neighbourhood Descriptive Analysis

Variable	n	%	Mean	SD	Min	Max
Neighbourhood			4.0155	1.03668	1.00	5.00
High (3.67-5.00)	1709	67.7				
Moderate (2.34-3.66)	658	26.1				
Low (1.00-2.33)	156	6.2				

Table 11.1: One-way ANOVA table for Superstitious Belief in Neighbourhood by Races Influence Housing Purchase Intention of Young Generation Homebuyers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	240.691	3	80.230	81.832	.000
Within Groups	2469.706	2519	.980		
Total	2710.397	2522			

Table 11.2: Tukey HSD Superstitious Belief in Neighbourhood

Race	N	Subset for alpha = 0.05				SD	Std. Error
		1	2	3	4		
Others	129	3.4264				3.4264	.58330
Malay	1117		3.7905			3.7905	1.16127
Indian	425		3.9765			3.9765	1.02534
Chinese	852			4.4190		4.4190	.74743
Sig.		1.000	.076	1.000		4.0155	1.03668

7. Dwelling Features

Table 12.0 reveals that 77.3% of respondents strongly believe in superstitions related to dwelling features when considering housing purchases, with an average score of 3.4356. A one-way ANOVA, as presented in Table 12.1, was conducted to assess how race influences these superstitious beliefs regarding dwelling features and their impact on housing purchase decisions. The analysis shows a significant effect of race on these beliefs (F=44.640, p=0.000). Post hoc comparisons using the Tukey HSD test in Table 12.2 illustrate that mean belief scores significantly differ among different racial groups: Chinese (M=4.43), Malay (M=4.17), Indian (M=4.04), and others (M=3.42). However, the means for the Malay and Indian races are in the same group, indicating no significant difference between these two races. These findings suggest that superstitious beliefs about dwelling features indeed influence housing purchase decisions. Specifically, Chinese potential homebuyers place significant importance on the features of the house when making their housing purchase decisions. For instance, superstitions dictate that the main door should be free of obstructions, as they can block positive energy. A larger main door is often associated with greater wealth and luck. The alignment of front and back doors, as well as the placement of a staircase at the front door, are also believed to impact finances. Bedroom layout matters, with the foot of the bed facing the bedroom door symbolizing death. The positioning and design of the entrance are considered, with curved paths preferred over straight ones. Lamp posts and trees near the entrance are believed to influence fortune and energy balance.

Table 12.0: Superstitious Belief in Dwelling Features Descriptive Analysis

Variable	n	%	Mean	SD	Min	Max
Dwelling Features			4.2002	0.95662	1.00	5.00
High (3.67-5.00)	1946	77.3				
Moderate (2.34-3.66)	454	18.0				
Low (1.00-2.33)	123	4.9				

Table 12.1: One way ANOVA table for Superstitious Belief in Dwelling Features by Races Influence Housing Purchase Intention of Young Generation Homebuyers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	113.919	3	44.640	51.724	.000
Within Groups	2174.001	2519	.863		
Total	2307.920	2522			

Table 12.2: Tukey HSD Superstitious Belief in Dwelling Features

Race	N	Subset for alpha = 0.05				SD	Std. Error
		1	2	3	4		
Others	129	3.4264				3.4264	.58330
Indian	425		4.0471			4.0471	.04741
Malay	1117		4.1710			4.1710	1.06439
Chinese	852			4.4319		4.4319	.97741
Sig.		1.000	.319	1.000		4.2002	.95662

CONCLUSION

Superstitious beliefs significantly impact the housing purchase intentions of young generations, especially within the Chinese community. The rejection of the null hypotheses (Ho1 and Ho2) confirms the strong correlation between superstitions and housing choices among the young generation, highlighting their influence on decision-making processes. *Feng Shui*, a traditional Chinese philosophy, plays a crucial role in shaping these beliefs, guiding positive energy, and warding off negative influences in housing. Despite the lack of scientific evidence, these beliefs persist, impacting the Malaysian real estate market. Recognizing the prevalence of superstitions, local developers and agents must adapt their marketing strategies to appeal to a diverse range of potential buyers. This understanding can drive residential property purchases and boost the real estate market. This research sheds light on the impact of superstitious beliefs on the Malaysian housing market, particularly among the young generation. The findings emphasize the need for a deeper understanding of cultural beliefs like *Feng Shui* in shaping buyer behavior. By acknowledging these beliefs, both buyers and developers can make informed decisions and tailor strategies to align with their target market's preferences. In conclusion, superstitions significantly influence housing purchase decisions, especially among the young generation and the Chinese community in Malaysia. Recognizing this impact is crucial for the real estate industry to thrive in this cultural context.

ACKNOWLEDGEMENTS

This work was supported by the Ministry of Higher Education (MOHE) Malaysia through the Fundamental Research Grant Scheme (FRGS) (Project Code: FRGS/1/2022/SSI02/UPM/02/1).

REFERENCES

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, 50, 179-211.

Alias, A., Hamsani, D. F., Chua, S., J., L., & Zaid, S. M. (2014). Psychologically impacted houses – superstitions and marketability problems. *Journal of Building Performance*, *5*(1), 34-49

Bajari, P. & Kahn, M. E. (2005). Estimating Housing Demand with an Application to Explaining Racial Segregation in Cities. *Journal of Business and Economic Statistics*.Volume 23 Issue 1 (Jan). Pp. 20-33.

Chia, J., Harun, A., Mohd Kassim, A. W., Martin, D., & Kepal, N. (2016). Understanding Factors that Influence House Purchase Intention among Consumers in Kota Kinabalu: An Application of Buyer Behavior Model Theory. *Journal of Technology Management and Business, 3*(2). Retrieved from https://publisher.uthm.edu.my/ojs/index.php/jtmb/article/view/1466

Chong, T. T. L. & Du, X. (2008). Hedonic pricing models for vehicles registration marks. *Pacific Economic Review*, *13*(2), 259-276.

Chu, Y. C., Hsu, M. F., & Hsieh, C. M. (2017). The Impacts of Site Selection and Planning of a Historic Settlement on a Sustainable Residence. *Applied Ecology and Environmental Research*, *15*(2), 145-157.

Fortin, N. M., Hill, A. J., Huang, J. (2014). Superstition in the Housing Market. *Economic Inquiry*, 52(3), 974-993. doi:10.1111/ecin.12066

Foster, K. R., Kokko, H. (2009). The evolution of superstitious and superstition-like behavior. *Proceedings of the Royal Society B*., 276, 31-37.

Flynn, B. B., Schroeder, R. G., & Sakakibara, S. (1994). A framework for quality management research and an associated measurement instrument. *Journal of Operations Management*, 11, 339-366.

Hui, K. M., Wai, C. W., & Mei, N. S., (2019). The Effect of Superstitious Belief on Property Purchase Intention. *International Journal of Real Estate Studies*, 13(2)/2019, 1-13, ISSN 1832-8505.

Hurtubia, B., Gallay, O., & Bielaire, M. (2010). Attributes of household, locations, and real estate for land use modeling. *Sustain City Working Paper*, 2.7. Lausanne: EPFL.

Leppel, K. (2007). Married and Unmarried, opposite-and Same-Sex Couples: A Decomposition of Homeownership Differences. *Journal of Housing Research*. Volume 16 Issue 1. Pp. 61-81.

Liang, C. C., & Osmadi, A. (2015). The Significance of *Feng Shui* in House Buying Selection among Malaysians. *Jurnal Teknologi (Sciece & Engineering)*, eISSN 2180-3722, 75:9, (2015) 15-19.

Sia, M.K., Yew, V.W. C. & Siew, C. L. (2018). Influence of *Feng Shui* factors on house buying intention of Malaysian Chinese, *Architectural Engineering and Design Management*, 14:6, 427 439, DOI: 10.1080/17452007.2018.1466684

Neo, S. M., Choong, W. W. & Ahamad, R. B. (2017). Differential environmental psychological factors in determining low carbon behaviour among urban and suburban residents through responsible environmental behaviour model. *Sustainable Cities and Society, 31,* 225-233.

Rehm, M., Chen, S. & Filippova, O. (2018). House prices and superstition among ethnic Chinese and non-Chinese homebuyers in Auckland, New Zealand. *International Journal of Housing Markets and Analysis*, *11*(1), 34-44.

San. C. (2016). *Attributes influencing homebuyers' purchase decision: A study of residential property in Setia Alam* (Master's thesis, University Tunku Abdul Rahman, Kuala Lumpur).

Tedong, P. A., Azriyati, W. N., Abd Aziz, W., Hanif, N. R. (2018). The Privatization of Public Streets and Urban Spaces in Malaysia. *Open House International*, *43*(3), 110-116.

Walters, D. (1988). Feng Shui. New York: Simon & Schuster.

Wong, W. C., Abdullah, N. A. H., & Lim H. E. (2017). The value of Chinese superstitions in Malaysia: Evidence from car plate auctioning. *The Singapore Economic Review*.

Wu, K.-S., & Teng, Y.-M. (2011). Applying the extended theory of planned behavior to predict the intention of visiting a green hotel. *African Journal of Business Management*, *5*(17), 7579-7587.

Wu, W. Y., Yau, O. H. M., Lu, H. Y. (2012). Feng Shui Principles in Residential Housing Selection. *Psychology and Marketing*, *29*(7), 502-518.

Xu, P. (1997). Feng shui as a clue: identifying the landform patterns of impact zones from the 2013 historic mountain floods in boulder and nearby areas, Colorado, USA. *International Scientific Journal Environmental Science*.

Yau, A. H. T. (2015). To be or not to be superstitious – That is the question. *Procedia-Social and Behavioral Sciences,* 208, 5-12.

Zyed, Z.S., Low, C.S., Tedong, P.A., (2021). Delivery mechanism on homeownership education among millennials in Kuala Lumpur, *International Journal of Housing Markets and Analysis. 14*(2), 410-423.

Received: 7th June 2023. Accepted: 5st September 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 357 – 372

AN EXPLORATION OF COMMUNITY ENGAGEMENT AND PARTICIPATION IN THE LOW CARBON CITY (LCC) INITIATIVE: CASE STUDY OF MAJLIS BANDARAYA SHAH ALAM

Yusfida Ayu Abdullah[1], Khalid Zanudin[2], Nor Baizura Jamaluddin[1], Marlyana Azyyati Marzukhi[1], Mohammad Yusup[1]

[1]*Centre of Studies for Town and Regional Planning,*
UNIVERSITI TEKNOLOGI MARA, UiTM SELANGOR, MALAYSIA
[2]*Faculty of Social Sciences and Humanities,*
UNIVERSITI MALAYSIA SARAWAK

Abstract

This research paper examines the state of community awareness and participation in the Low Carbon City (LCC) initiative by the Majlis Bandaraya Shah Alam (MBSA). The study aimed to explore the level of understanding, awareness, and involvement of the community in the low carbon city initiative, and to identify the factors that influence community participation. The study employed a qualitative approach where focus group discussions involving key stakeholders were conducted, and subsequently, thematically analysed. The findings suggest that the level of community awareness and participation in the low carbon city initiatives in Shah Alam is relatively low. Factors such as participation and information-sharing methods, and a lack of collaboration between stakeholders were identified as barriers to community participation. The study recommends that MBSA prioritises community engagement and education, including best practices, to increase community awareness and participation. In addition, the methods for participation and information sharing should be tailored to the target group. The findings also suggested continuous discussion and engagement among the stakeholders, especially between the communities and the local authority, can promote active participation in the LCC initiatives among the communities in Shah Alam.

Keywords: Community participation, low carbon city, carbon reduction, climate change, Majlis Bandaraya Shah Alam

[2] Lecturer at Universiti Malaysia Sarawak. Email: zkhalid@unimas.my

INTRODUCTION

In response to the growing threat of climate change, and the need for sustainable development, many cities worldwide have developed Low Carbon City (LCC) initiatives. These efforts attempt to minimise carbon emissions, enhance energy efficiency, and stimulate the use of renewable energy sources. In recent years, the city of Shah Alam, through its city council called the Majlis Bandaraya Shah Alam (MBSA), has adopted its own LCC initiatives with the purpose of establishing a sustainable and low carbon urban environment through various strategies, including energy-efficient buildings, green transportation, and green communities.

In spite of its potential benefits, it is yet to be determined how participative the community has been in the LCC initiative. As with such sustainable development initiatives, community engagement and participation are critical factors in their success. With active community participation, the LCC initiative will be able to achieve its goals. Therefore, the aims of this study were (1) to explore the level of understanding, awareness, and involvement of the community in the low carbon city initiative, and (2) to identify the factors that influence community participation.

This paper reviews the relevant literature on carbon reduction, low carbon cities, and community participation. Thereafter, it describes the methodology used to collect and analyse the data, whereby the Focus Group Discussion was the primary method for collecting data involving various key stakeholders. The results of the study are then presented and discussed, followed by the conclusion. Overall, this study sought to contribute to the understanding of community engagement and participation in implementing low carbon city initiatives, hence providing insights and recommendations for improving the effectiveness of the LCC initiative by MBSA.

CARBON REDUCTION, LOW CARBON CITY AND COMMUNITY PARTICIPATION

Low Carbon City (LCC) initiatives have increasingly gained attention in recent years as a response to climate change and urbanisation challenges. The United Nations (UN) has recognised the importance of reducing greenhouse gas (GHG) emissions, and improving energy efficiency in cities, and has called for cities to take action on climate change (United Nations, 2022).

In addition, LCC initiatives also provide benefits, such as improved air quality, reduced traffic congestion, and increased green spaces, which then improve the quality of life for communities, and enhance the economic competitiveness of cities (Wu et al., 2022; Su et al., 2013). These also contribute to achieving carbon reduction, which is the ultimate goal of LCCs in the first place, for which community participation is crucial. Community engagement and participation in these LCC initiatives, which encompass a range of activities and levels of engagement, from information sharing to decision making, can enhance their effectiveness and sustainability, and promote social inclusivity. Nevertheless, Arnstein (1969) depicted community participation as a ladder that benefits only certain stakeholders and community segments with more considerable influence.

Conceptually, community participation helps the decision makers to make better decisions by incorporating the community's experiential knowledge into the process (OECD, 2017). Furthermore, it promotes the democratisation of the decision making by considering the interests of various stakeholders, thus resolving conflicts.

Several studies have shown the positive effects of community participation in achieving carbon reduction, and LCC goals. For example, studies in Bangkok demonstrated the prominent role of community participation in successful low carbon city initiatives and programmes (Leknoi et al., 2022; Leknoi, 2019). Another study in China suggested that communities are essential in reducing carbon emissions (Liu et al., 2021). A sense of ownership among the communities should be encouraged whilst supervision by the authorities is also important to guide the community towards sustainability.

However, the effectiveness of community participation in achieving carbon reduction and LCC goals depends on various factors, such as the level of community engagement, the quality of communication and collaboration, the institutional and political contexts, and the availability of resources and support.

Besides that, psychological factors have been discussed as contributors influencing an individual's willingness to participate in low carbon initiatives. Apparently, more environmentally conscious people are more likely to participate (Wu et al., 2022). This can be associated with the habitual preferences and behaviours displayed by individuals with better awareness and attitudes towards a sustainable environment. Even with this, several researchers argued that there is a gap between awareness, and the willingness to take action. While most people are aware of climate change and low carbon consumption, they are unwilling to modify their behaviour and lifestyle (Ding et al., 2018; Howarth, 2017; Mei et al., 2017).

In addition, social factors like communication and the relationship with relevant agencies and among community members potentially hinder participation levels within the community. Their perception of carbon reduction and sustainability, and trust in government agencies play an essential role in influencing the communities' willingness to participate. In other words, those with a strong sense of community, and a good relationship with these agencies are more likely to engage in collective action for the benefit of the community (Wu et al., 2022; Samaddar et al., 2019).

Institutional openness and responsiveness to community input and feedback can affect the perceived legitimacy and effectiveness of low carbon initiatives, and thus influence community participation (Guo & Wang, 2023). Community participation may be influenced by the degree to which institutions seek to engage the community in the planning, implementation, and evaluation of the implementation of LCCs.

Meanwhile, situational factors, including government policies and social media, can contribute to an individual's behaviour and perception towards low carbon programmes and initiatives. The existence of policies that give incentives to the communities and other stakeholders will affect the communities' awareness, and willingness to participate. Moreover, the role of social media and technology potentially enhances the promotion of the LCC initiative, thus leading to social change in the community (Vavaenesh et al., 2022; Cheng et al., 2021).

Therefore, understanding the complex and dynamic factors that influence community participation in low carbon initiatives, henceforth the LCC goal, is essential for developing effective strategies. Policymakers are able to design LCC initiatives and programmes that are more inclusive, and tailored to the target group by considering the individual, social, institutional, and contextual factors that influence community participation.

SHAH ALAM LOW CARBON CITY JOURNEY

Background of Low Carbon City Initiatives in Malaysia

In response to the climate change, the Malaysian government's commitment to sustainable development, and a 40% reduction in carbon emissions by 2020 is the root of the country's low carbon city (LCC) projects. The National Green Technology Policy (NGTP), launched by the government in 2009, aims to advance green technology, and sustainable development. With the encouragement of the NGTP, LCCs were highlighted as one of the major sectors for green technology development (Ministry of Energy, Green Technology and Water, 2017).

In order to address this, the Malaysian government, through the Ministry of Energy, Green Technology, and Water (KeTTHA), developed and launched the Low Carbon Cities Framework (LCCF) in 2012, a guideline for cities to develop low carbon strategies and initiatives. The LCCF promotes energy efficiency, sustainable mobility, waste management, and the use of renewable energy sources as a comprehensive strategy for cities to decrease their carbon footprint (Ministry of Energy, Green Technology, and Water, 2017).

The LCCF connects government policy to the numerous green-city rating methods on the market. Given the government's commitment to decreasing carbon emissions, this framework assists stakeholders in cities and townships in identifying their objectives, and developing action plans to reduce carbon emissions. The framework has been specially designed to concentrate on tactics and actions that may be implemented to lower carbon emissions.

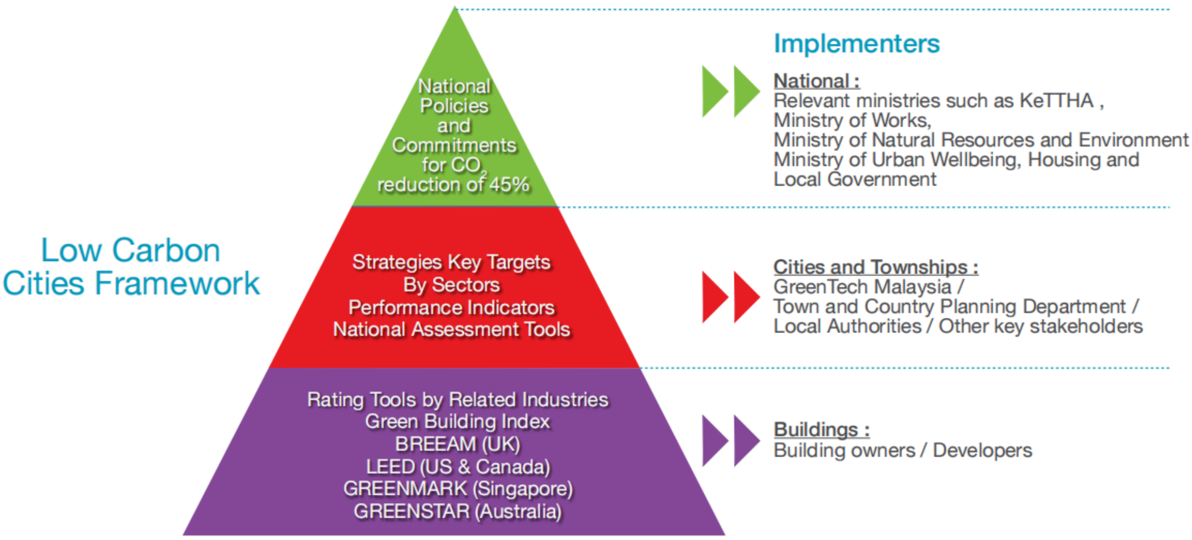


Figure 1: LCCF in Relation to National Policies and Rating Tools
(Source: Ministry of Energy, Green Technology and Water, 2017)

Since the launch of the LCC initiative, several cities have embarked on LCC development projects and initiatives. For example, Shah Alam has developed the Shah Alam Low Carbon City Action Plan (SALCCAP) 2017-2030, which aims to achieve an absolute greenhouse gas (GHG) emission reduction of 45% by 2030 (Majlis Bandaraya Shah Alam, 2021). This initiative was further built upon with the Shah Alam Low Carbon City Action Plan 2035 in 2021.

Overall, the low carbon city initiatives in Malaysia aim to promote sustainable urban development, and reduce carbon emissions to mitigate the impact of climate change while ensuring economic growth and development.

The Low Carbon City Initiatives by MBSA

Majlis Bandaraya Shah Alam (MBSA) is one of the local authorities in Malaysia that has taken proactive steps towards becoming a low carbon city. The initiative is part of the government's commitment to reducing carbon emissions under the Low Carbon Cities Framework (LCCF) launched in 2012. The LCCF aims to help cities in Malaysia transition towards a low carbon economy, and build resilience against the impacts of climate change.

MBSA's low carbon city initiatives started with the development of the Shah Alam Low Carbon City Action Plan (SALCCAP) 2017-2030 in 2017, which outlined a roadmap for sustainable development, and carbon reduction in the city. The SALCCAP, which is based on five (5) thrusts, namely Green Solid Waste Management, Efficient and Effective Use of Energy and Water Resources, Efficient Public Transportation and Mobility Services, Integrating Nature in the Built Environment, and Green Technology Oriented City Administration and Management, provided a blueprint for MBSA's low carbon city initiatives, and helped to guide the implementation of various programmes and policies (Majlis Bandaraya Shah Alam & Universiti Teknologi MARA, 2021).

In 2015, MBSA entered a collaboration with the Ministry of Energy, Green Technology & Water (KeTTHA), Malaysia Green Technology Corporation (GreenTech), and the Malaysian Institute of Planners (MIP) to implement the Low Carbon City Framework (LCCF) in Shah Alam. The first LCCF project implemented was at the city centre of Shah Alam (Seksyen 14), a pilot project covering an area of 395 acres. Following this implementation, MBSA was awarded the "Diamond Recognition" at the International Green Exposition Malaysia (IGEM) 2018 for being the pioneer of the "City Based Approach" in Malaysia (Majlis Bandaraya Shah Alam & Universiti Teknologi MARA, 2021). The latest recognition received by MBSA following their commitment towards making Shah Alam more sustainable and less carbon was during the Low Carbon City 2030 Challenge (LCC2030C), where MBSA was granted 25 awards (MGTC, n.d).

Some of the low carbon city initiatives implemented by MBSA to reduce its carbon footprint and promote sustainable development include (Majlis Bandaraya Shah Alam, 2017):

a. Sustainable transportation: MBSA has promoted eco-friendly transportation options by setting up a bicycle-sharing system, installing bicycle lanes, and offering free shuttle bus services. This encourages people to reduce their use of private vehicles, and thus opt for sustainable transportation.
b. Waste reduction and recycling: MBSA has implemented several waste reduction and recycling programmes, such as "Zero Waste", and community recycling programmes, to encourage residents to separate and recycle their waste. These programmes also aim to reduce food waste, and organic compost waste.
c. Renewable energy: MBSA has installed solar panels on its buildings, including the MBSA headquarters, community halls, and public libraries, to generate renewable energy, and reduce their dependence on grid electricity.
d. Greenery in the city: MBSA has launched several tree planting programmes, such as the "Shah Alam Trees for Life" programme, to increase green areas and infrastructures in the city, and reduce carbon emissions.
e. Community participation: MBSA has initiated programmes such as *Pertandingan Laman Komuniti Shah Alam*, urban farming, and green

initiatives at the pre-school level, to educate and engage the community on environmental issues, and encourage them to take action.

Table 1: Programs and activities organised by MBSA

Sectoral	Programs and Activities
Urban Environment	i. Trees for life ii. Tree Planting Program iii. Landscape competition iv. Shah Alam Orchid Show v. Community Green Initiative like urban farming, *Pertandingan Laman Komuniti Shah Alam* and Laman *Mini Zon Bersih* vi. Green Earth program that focuses on collaboration with all primary school in Shah Alam and residents' associations
Urban Transportation	i. 'Smart Selangor Bus' is a free bus service ii. Promoting micro-mobility through bike-sharing and e-scooter sharing iii. Providing supporting infrastructure like bike lane alignment, particularly at the first and last mile of public transport iv. Car-free Day
Urban Infrastructure	i. Zero Waste Program ii. Community and School Recycling Program iii. Neighbourhood Recycling Centre iv. Composting of waste from market and landscape v. Waste separation from source
Green Community	i. Urban farming ii. *Pertandingan Laman Komuniti Shah Alam* iii. *Mini Zon Bersih* iv. Green Earth program with all primary schools in Shah Alam and residents associations v. Green initiative for pre-schools

Source: Majlis Bandaraya Shah Alam (2017)

Overall, MBSA's low carbon city initiatives demonstrate its commitment to promoting sustainable development, and reducing carbon emissions in its jurisdiction. By implementing these initiatives, MBSA aims to create a more liveable, sustainable, and resilient city for its residents.

RESEARCH METHODOLOGY

This study employed a qualitative approach to assess community engagement and participation in the Low Carbon City (LCC) Initiative implemented by Majlis Bandaraya Shah Alam (MBSA). It involved the collection of primary data, with emphasis on the focus group discussion (FGD) approach to gather qualitative data on the low carbon city initiatives that MBSA implemented. The FGD involved nine participants who were selected using purposive sampling based on their experiential knowledge and involvement in implementing the MBSA's low carbon city initiatives. These participants included representatives from selected communities, kindergartens, local councillors, and non-government organisations (Table 2).

Table 2: List and Background of Participants

Bengkel Focus Group Discussion Pelan Tindakan Bandar Rendah Karbon
Thrust: *Communication, Education, and Public Awareness*
Date: 15th June 2021
Total Participants: 9

ID	Agency	Position
PA1	Komuniti Surau Al-Husna, Seksyen 20 Shah Alam	Chairman
PA2	Taska Sarjana Pintar	Teacher
PA3	Taska Sarjana Pintar	Teacher
PA4	Taska Sarjana Pintar	Teacher
PA5	Persatuan Lestari Alam Malaysia	President
PA6	Persatuan Lestari Alam Malaysia	Committee Member
PA7	Majlis Perwakilan Penduduk Zon 8	Local Councillor
PA8	Majlis Perwakilan Penduduk Zon 22	Local Councillor
PA9	Treat Every Environment Special (TrEES)	Committee Member

The FGD was conducted mainly in Bahasa Malaysia as it is the researchers' and respondents' mother tongue with only several English terminologies used. In addition, the sessions were conducted over an online meeting platform due to the COVID-19 pandemic, which disallowed such discussions to be carried out physically. The researchers moderated the discussion, and posed open-ended questions to the participants regarding MBSA's low carbon city initiatives. The questions were designed to explore the participants' perceptions of the initiatives, the challenges and opportunities associated with their implementation, and the effectiveness of MBSA's strategies in reducing carbon emissions.

The FGD was recorded via the online meeting platform, and transcribed using an edited transcription approach, which is described in a later section. The data was then analysed using a thematic analysis approach, which involved identifying patterns and themes in the data, and interpreting their meanings. The study employed Braun and Clarke's (2006) framework for the analysis process. They had structured thematic analyses into six (6) main steps, to which this study adhered closely to.

Step 1 – Transcribe and familiarise the data: Audio data recorded from the interviews were listened to repeatedly, and transcribed using the edited transcription approach. This meant that the phrases that appeared irrelevant and excessive were omitted while maintaining the text's essence (Salonga, 2018). The readability of the document was important to make it appealing. Step 2 – Generate initial codes: At this stage, only data relevant to the research questions were coded, which were in the form of statements. Similarities between the interview responses were highlighted and organised. Transcripts were reviewed several times with new or modified codes updated. Step 3 – Search for themes: All relevant coded data were organised into different themes. A table was used to classify and display the relationships between the themes and codes, which helped in reviewing the level of themes, leading to the emergence of sub-themes. Also, it was possible for the codes to be linked to more than one theme.

Step 4 – Review themes: All themes, sub-themes, and codes were revised and modified to establish coherent connections between them. At this point, the fundamental question was: Does each connection seem relevant? The researchers used the 'cut and paste' function in Microsoft Office to reorganise the data in the transcript. Step 5 – Define themes: The main questions asked at this stage were: What are the relations built between the themes and sub-themes? How do these relations attain the research questions? Step 6 – Reporting: The findings were finally reported.

RESULTS AND DISCUSSION

The result of the analysis would highlight the importance of community understanding and education in achieving sustainable practices, including the concept of a low carbon city. As such, assessing the level of understanding and awareness of the community in Shah Alam regarding the low carbon concept and initiative was crucial.

As shown in Table 3, the results indicate that the communities in Shah Alam might have a limited understanding of low carbon, which can hinder their ability to contribute actively [PA1, PA5, PA7, PA8, PA9].

> *Bagi saya masyarakat masih kurang faham apa konsep rendah karbon, dan mungkin apa yang mereka lakukan sehari-harian secara peribadi ataupun perseorangan, mereka telah mencapai certain objektif, tetapi mereka tidak sedar bahawa itu memberi sumbangan kepada target rendah karbon* (Participant PA9).

Therefore, there is a need to educate and raise the awareness of the community of Shah Alam regarding the low carbon concept, and its benefits. Furthermore, the participants emphasised the importance of community involvement in low carbon city projects and initiatives. This was mentioned by most participants (67%), who highlighted the importance of encouraging community participation and engagement in these projects and initiatives to ensure their success [PA1, PA5, PA6, PA7, PA8, PA9].

> *…apa yang kita lihat sekarang ini ialah bagaimana MBSA educate dan adakan banyak bengkel untuk setiap lapisan komuniti supaya mereka tahu apa hala tuju.*
> *...Bagi saya, low carbon ini, semua masyarakat kena ambil tanggungjawab because when we talk about low carbon, berjalan, semua orang berjalan. That's is some of the component of low carbon*
> (Participant PA5).

Meanwhile, three participants [PA1, PA5, PA9] highlighted the importance of learning from the best practices of those who have successfully implemented this initiative. It was suggested that the community may benefit from others' experience in conducting and handling low carbon city programmes and initiatives, where they might gather a better understanding, and observe the potential benefits the community could gain. However, only two participants [PA5, PA6] suggested the need to educate the community at an early age as part of the effort to accomplish behavioural change among the communities (Table 3).

In relation to the factors that influence the Shah Alam communities' involvement in the low carbon city initiatives, the results of the thematic analysis indicate that both the method of participation, and the method of information sharing are essential when it comes to encouraging their participation (Table 4). Nearly 67% of the participants stated the importance of tailoring the method of participation to the specific target as different segments and target groups might require a different approach that is closely associated with their socio-economic background [PA1, PA5, PA6, PA7, PA8, PA9]. Likewise, six out of nine participants highlighted the importance of effective communication strategies to ensure that important messages and information are easily accessed, and effectively reach the target group (Table 4).

> *Selalunya masalah yang kita hadapi dalam mencapai objektif ini adalah disebabkan oleh maklumat itu tidak sampai kepada kumpulan sasaran.…Jika kumpulan sasaran kita itu kebanyakkannya adalah dikalangan golongan muda atau remaja, pendekatannya mungkin berbeza* (Participant PA6).

Both those factors are followed by the need for continuous collaboration between stakeholders, especially between the local authorities and communities. More than 50% of the participants agreed that a collaborative approach in the low carbon city initiative would enhance the community's capacity to participate by engaging their interest in the entire process, particularly in the decision making [PA1, PA5, PA7, PA8, PA9].

> *Kami ajak tadika dan taska yang berada di sekitar komuniti kami untuk bersama dengan jawatankuasa surau dalam membuat kebun komuniti, aktiviti kitar semula, buat baja kompos, buat tenaga solar, bela ikan, pokok-pokok nadir. Bila tengok itu, kita letak nama pada pokok-pokok itu. Jadi, anak-anak tadika faham tentang konsep sampah, konsep kitar semula dan akhirnya dia boleh amalkan di rumah* (Participant PA1).

Apart from these factors, a few participants also pointed out other aspects that prospectively affect the capability of the Shah Alam communities to participate. Some participants [PA1, PA5, PA9] believed that the local authorities should provide financial grants, or other resources to encourage the community to engage in the low carbon city initiatives. In other words, local authorities should actively ensure sufficient resources and infrastructures are provided to support the low carbon initiative, and promote community participation in these programmes (Table 4).

Moreover, PA1, PA5, and PA9 highlighted the need to adopt technology in monitoring and managing the process of implementing the low carbon city programmes, including community participation. They believed that it is crucial to have a proper database that can be used to monitor and assess the progress made by the communities and local authorities in executing these initiatives.

Meanwhile, incentives, rewards, and any forms of acknowledgement are fundamental in encouraging the communities to participate in the programmes and initiatives, which ultimately contribute to behavioural change in the communities [PA6, PA7, PA8].

Overall, this study aimed to explore the community's understanding, awareness, and involvement in the low carbon city initiative, and identify the factors influencing community participation. The results indicated that the community in Shah Alam may possess a limited understanding of the low carbon concept, which can hinder their ability to actively participate in the LCC initiatives by either the communities themselves, or the local authorities (Table 3).

Following the FGD, most participants [PA1, PA5, PA6, PA7, PA8, PA9] underlined the importance of community participation in low carbon city projects and initiatives to ensure their success. Meanwhile, several participants also highlighted the importance of learning from the best practices, which can be done by looking at the experiences and current practices of other communities or countries (Table 3).

Nevertheless, the analysis results have identified two prominent factors influencing community participation in low carbon initiatives: participation and information-sharing methods. The main argument by the participants during the

FGD was that appropriate methods for participation and communication that are suited and tailored to specific target groups should be identified instead of utilising generalised methods (Table 4). Table 4 also highlighted the importance of continuous collaboration between stakeholders, especially local authorities and communities, in enhancing the community's capacity to participate in such initiatives.

In addition, a few other factors that facilitate community participation in low carbon programmes and initiatives were highlighted throughout the discussion, namely, the need for financial grants, or other resources [PA1, PA5, PA9]; technology adoption in monitoring and managing the entire implementation process [PA1, PA5, PA9]; and the importance of incentives and acknowledgements that may thus contribute to positive behavioural change [PA6, PA7, PA8].

Table 3: Level of Understanding and Awareness of Community

Theme	Code (statements)	PA 1	PA 2	PA 3	PA 4	PA 5	PA 6	PA 7	PA 8	PA 9
Importance of community participation	Understanding the importance of community participation in projects and initiatives.	✓				✓	✓	✓	✓	✓
Understanding of the concept	The community still has a limited understanding of the concept of low carbon, which hinders their ability to actively contribute.	✓				✓		✓	✓	✓
Behavioural learning and change	Behavioural change is crucial in achieving sustainable practices. Thus, schools and universities should involve in educating students about sustainability.					✓	✓			
Method of learning	Importance of providing adequate training to the community before implementing a program to ensure the program's success.				✓		✓			
Capacity building and Mentorship	Community leaders can play a role in guiding and mentoring community members to build their capacity. It is also part of strategies for identifying and nurturing emerging leaders.					✓				✓

Best practices in other communities and countries	Organizing visits to successful community initiatives and programs or observing practices in other countries like Indonesia are the way to encourage communities' interest, hence participation	✓				✓				✓

The theme that has high impact Theme that has moderate impact Theme that has low-impact
*Throughout the focus group discussion, both participants PA2 and PA3 faced difficulties in participating due to technical and connectivity issues.

Table 4: Factors Influence Community Participation

Theme	Code (statements)	PA 1	PA 2	PA 3	PA 4	PA 5	PA 6	PA 7	PA 8	PA 9
Method of Participation	Importance of tailoring the approach to the specific community for the effectiveness of the method, and programs.	✓				✓	✓	✓	✓	✓
Promotion of low carbon concept	It is important to instil and promote sustainable development, and practices among urban communities.	✓								
Information sharing and communication	Effective communication strategies are fundamental to ensuring information reaches the intended target group.	✓			✓	✓	✓		✓	✓
Financial and resource	Importance of financial grants to be provided for the successful implementation of community projects.	✓				✓				✓
Collaboration between stakeholders	Importance of collaboration between stakeholders for the implementation of projects aimed at raising awareness and building community capacity.	✓				✓		✓	✓	✓
Technology and data management	Importance of data of low carbon initiative to track progress. Besides, the adoption of technology can facilitate the data management process.	✓				✓				✓
Government's Role and Initiative	Local authorities should play an active role in providing resources and infrastructure to support low carbon initiatives and promote community participation in the program.					✓	✓			✓
Leadership and representation	The success of any initiative depends on effective leadership and communication. Importance to involve community leaders and inform them of government policies and goals.					✓			✓	
Government policies and guidelines	The importance of sustainability-related policies like the New					✓				✓

	Urban Agenda aligns with the community's inspiration.				
Role of social media	Importance of the awareness of low carbon agenda being spread through social media.	✓			
Incentive and benefit	Importance to providing rewards, acknowledgment, and incentives as a means of encouraging positive behavioural change.		✓	✓	✓

The theme that has high impact | Theme that has moderate impact | Theme that has low-impact

*Throughout the focus group discussion, both participants PA2 and PA3 faced difficulties in participating due to technical and connectivity issues.

CONCLUSION

This paper explores the community's current understanding and participation in the LCC initiatives conducted by MBSA. This study also contributes to a better understanding of the factors that influence community participation in the initiatives. The results indicate that the community of Shah Alam might require a better grasp of the low carbon idea to allow them to actively participate in the LCC initiatives, whether initiated by the community, or the local authority. This can be achieved by learning from other communities or countries that have successfully implemented LCC initiatives, hence encouraging changes in the behaviour of the communities towards low carbon practices. The study also revealed two main factors contributing to community participation in the LCC initiatives, namely the method for information sharing and participation. It is essential to have both processes customised according to different community segments, or target groups to ensure greater understanding and participation by the community. Besides that, collaboration between stakeholders was highlighted as a means to enhance the community's capacity to participate in low carbon programmes and initiatives. As a result, it is anticipated that the findings will help MBSA, and potentially other local authorities to be able to address the shortcomings of the current practices, and hence, promote more effective community participation in the LCC initiatives. Subsequently, a few areas can be addressed in the future, including replicating the study using a quantitative research method as, due to its statistical attributes, it may result in different outcomes.

ACKNOWLEDGEMENTS

The authors would like to thank the Ministry of Higher Education for awarding the Fundamental Research Grant Scheme (FRGS) [FRGS/1/2021/SS0/UITM/02/46] and MBSA for their tremendous support. Also, the authors would like to acknowledge the Research Management Centre (UiTM Selangor) and UiTM Selangor for supporting this project. This project was also made possible with the provision of data and input from not only MBSA but also its stakeholders and the community of Shah Alam. To those indirectly involved in this study, we also appreciate your participation, assistance, and effort.

REFERENCES

Arnstein, S. R. (1969). A Ladder of Citizen Participation. *Journal of the American Institute of Planners, 35*(4), 216–224.

Ding, Z., Jiang, X., Liu, Z., Long, R., Xu, Z., & Cao, Q. (2018). Factors affecting low carbon consumption behavior of urban residents: A comprehensive review. *Resources, Conservation and Recycling*, 132, 3-15.

Guo, J., & Wang, H. (2023). Study on carbon emission reduction effect of institutional openness in China. *Scientific Reports, 13*(1), 254.

Howarth, C. (2017). Informing decision making on climate change and low carbon futures: Framing narratives around the United Kingdom's fifth carbon budget. *Energy research & social science*, 31, 295-302.

Leknoi, U., Yiengthaisong, A., & Likitlersuang, S. (2022). Community engagement initiative amid climate change crisis: Empirical evidence from a survey across Bangkok Metropolis of Thailand. *Cities*, 131, 103995.

Leknoi, U. (2019). Transition Factors to Low Carbon Community-Engagement Initiative for Slum Communities. *International Journal of Energy Economics and Policy, 9*(6), 358-365.

Liu, T., Wang, Y., Li, H., & Qi, Y. (2021). China's low carbon governance at community level: A case study in Min'an community, Beijing. *Journal of Cleaner Production*, 311, 127530.

Majlis Bandaraya Shah Alam (2021). Shah Alam LCC Action Plan 2017 - 2030 Review Report. Shah Alam. MBSA.

Majlis Bandaraya Shah Alam & Universiti Teknologi MARA (2021). Shah Alam Low Carbon City Action Plan 2035. Shah Alam. Majlis Bandaraya Shah Alam.

Majlis Bandaraya Shah Alam (2017). Shah Alam Low Carbon City Action Plan 2030. Majlis Bandaraya Shah Alam.

Malaysian Green Technology and Climate Change Corporation (MGTC). (n.d.). MBSA raih 25 Anugerah Pengiktirafan Berlian bagi Cabaran Bandar Rendah Karbon 2030. MBSA raih 25 Anugerah Pengiktirafan Berlian Bagi cabaran Bandar Rendah Karbon 2030 – Malaysian Green Technology and Climate Change Corporation. https://www.mgtc.gov.my/ms/2023/03/mbsa-raih-25-anugerah-pengiktirafan-berlian-bagi-cabaran-bandar-rendah-karbon-2030/

Mei, N. S., Wai, C. W., & Ahamad, R. (2017). Public environmental awareness and behaviour in Malaysia. *Asian Journal of Quality of Life, 2*(5), 43-53.

Ministry of Energy, Green Technology and Water (2017). Low Carbon Cities Framework. Putrajaya. KeTTHA.

Ministry of Energy, Green Technology and Water (2017). National Green Technology Master Plan 2017-2030. Putrajaya. KeTTHA.

OECD. (2017). The Governance of Land Use in OECD Countries: Policy Analysis and Recommendations.

Salonga, S., (2018). Types of transcription: Verbatim vs Intelligent vs Edited Transcription. https://www.globalme.net/blog/verbatim-vs intelligent-vs-edited-transcription

Samaddar, S., Ayaribilla, A. J., Oteng-Ababio, M., Dayour, F., & Yokomatsu, M. (2019). Stakeholders' perceptions on effective community participation in climate change adaptation. Sustainable solutions for food security: Combating climate change by adaptation, 355-379.

Su, M., Li, R., Lu, W., Chen, C., Chen, B., & Yang, Z. (2013). Evaluation of a low carbon city: method and application. *Entropy, 15*(4), 1171-1185.

United Nations. (2022). The Sustainable Development Goals Report.

Wu, Y., Martens, P., & Krafft, T. (2022). Public Awareness, Lifestyle and Low carbon City Transformation in China: A Systematic Literature Review. *Sustainability, 14*(16), 10121.

Vavaenesh, S. D. A., Ramesh, L., Lee, L. C., Mustapha, M. H., Shahrin, N. N. A., & Hukil, S. (2022). The Potential and Challenges of Ampang Jaya Municipal Council (MPAJ) Towards Achieving Low Carbon City (LCC): Community Perspective. *Jurnal Pengajian Umum Asia Tenggara* 23 (2022): 292-304.

Received: 24th July 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 373 – 386

THE IMPACT OF ONLINE SHOPPING ON SHOPPING CENTRES IN KLANG VALLEY, MALAYSIA

Yasmin Mohd Adnan[1], Chin Kee Liang[2], Muhammad Najib Razali[3]

[1]*Department of Real Estate, Faculty of Built Environment,*
UNIVERSITI MALAYA
[2]*Henley Business School,*
UNIVERSITY OF READING MALAYSIA
[3]*Department of Real Estate, Faculty of Built Environment & Surveying,*
UNIVERSITI TEKNOLOGI MALAYSIA

Abstract

Real estate has been a spectator to technology disruption for the past few years as many activities that used to be mediated by physical spaces within buildings are presently being shifted to virtual space. Markedly, this is the case in shopping as brick-and-mortar retailers are being disrupted by e-commerce. This study's premise is that it is not clear whether the emergence of online shopping would transform the physical retail property sector in Malaysia. To gauge the impact of the disruption on the physical space, this study conducted a survey among the shoppers in Klang Valley, Malaysia to determine the preference of shoppers to shop virtually or in the physical spaces at shopping centres. From the findings, it is found that the virtual space is not identified as an immediate and direct threat to physical space by shoppers. The synergies between the virtual space and physical space have to be explored so that the existing physical spaces can be designed to ensure sustainability with shoppers' preferences.

Keywords**:** Online Shopping, Shopping Centres, Physical Space, Virtual Space

[1] Corresponding Author Email: yasmin_alambina@um.edu.my

INTRODUCTION

With the emergence of the digital economy, retail property could be affected in several ways, such as the reduction of rent per square foot and gross sales. Traditional shopping will become less appealing as Internet transactions become more common. According to the Department of Statistics Malaysia, there are around 25.08 million internet users in Malaysia compromising 79% of the total population as of 2019. In addition, Malaysia's overall e-commerce income performance in 2021 recorded RM1.1 trillion, an increase of 21.8% compared to 2020. The digital economy is expected to contribute 25.5% to the country's gross domestic product (GDP) by 2025, according to the 12th Malaysia Plan (12MP), a document released by the Economic Planning Unit (EPU), Malaysia (Economic Planning Unit, 2015).

Parallel to the emergence of virtual space that might have contributed to falling footfalls in physical retail space; the intrinsic inefficiencies of the property market are worsening the situation. Demand lags for new spaces have led to a massive oversupply of retail physical space in some markets across Malaysia, especially the Klang Valley. This study covers shopping centres (and excludes arcades and hypermarkets) located in the Klang Valley. Geographically the study area covers Wilayah Persekutuan Kuala Lumpur, Wilayah Persekutuan Putrajaya and some districts in Selangor. The occupancy rate has been showing a drop since 2018. It was reported by NAPIC (PMR, 2022) that the overall performance of the shopping complex continued to moderate, recording an occupancy rate of 75.4%, down from 76.3% in 2021.

The potential effects of e-commerce on the traditional retail property could eventually be profound as the rapid development of e-commerce may reduce the demand for physical space within the retail property market (Zhang et. Al, 2016). This study attempts to uncover the shoppers' preference towards online shopping and physical shopping and whether shopping centres could be threatened by the emergence of e-commerce in Malaysia. The study also has the objective to determine the shoppers' relative preference for one space versus the other in terms of drivers for that space and preferences in that space irrespective of the other space's characteristics. In addition, this study intends to measure the typical customer journeys for a consumer good purchase, a typical customer journeys for a consumer good purchase (physical goods) in which the journey is measured with four touchpoints corresponding to shoppers' arbitrage/preferences between physical and virtual spaces at the decision-making stages of their journey. Customer journeys are comprehensive as they cover the process from decision-making (prepurchase: touchpoint 1) to experience sharing (post-purchase: touchpoint 4) in accordance with the marketing literature.

LITERATURE REVIEW

Impact of E-Commerce and Online Shopping

By 2023, the e-commerce market is predicted to fetch US$5.7 billion with the number of users expected to amount to almost 22 million (Statista, 2022). With the advent of e-commerce within the retail sector, an earlier study by Razali et al. (2014) has highlighted that there will be no impact on the spaces of shopping centres. However, Lund (2020) and McGowan (2019) argued that with the increasing connectivity and online shopping among shoppers, the physical spaces at shopping centres will eventually be reduced. As in the case of Malaysia, the occupancy rate of shopping centres has been showing a drop in the occupancy rate since 2018. A study in China by Zhang et al (2016) has found that there is a minimal impact of e-commerce on the demand for commercial retail space. The relationship between online retailing and physical retailing has been seen as substitutes or complements (Dixon & Marston, 2002, Dixon & Marston, 2005).

E-commerce has been said to impact physical shopping space in several ways, including i) geocentric shopping advantages, based on distance and location, become less important as consumers go online; ii) retailers may decide to lead or follow customers online, causing a further migration of sales and a decrease in individual store performances; iii) retailers alter their virtual and physical sales channel mix, impacting on their leasing needs; and iv) rent and property values are affected, which in turn influences lender and investor expectations (Dixon & Marston, 2005). More recent studies on the impact of online shopping have shown the varying impact of online shopping on shopping centres. In Slovakia, a combination of omnichannel approaches was adopted in commercialising the merchandise (Hasan, 2019). The report by Savills (Savills Commercial report, 2018), has shown that the physical space is proving to be both a complementary and synonymous part of the brands' overall omnichannel strategy. Customers usually research online information about the products before buying, thus the need to adopt the omnichannel approach.

Shoppers' Motives and Attitudes Toward Physical and Online Shopping

It has been said that shoppers' motives and attitudes towards shopping often vary significantly depending on factors affecting shopping centres as their shopping behaviours can be for the achievement of utilitarian goals (Hastreiter and Marchetti, 2016). Another study on shopping behaviours at shopping centres in the Middle East has revealed three (3) main shopping motives: hedonic, efficiency, and accomplishment (Koksaiv, 2019). Hence, shoppers' attitudes towards shopping at centres differ and are somewhat unpredictable based on the centres' overall image, such as location, nature and quality of product assortment, prices, services, physical attributes, tenant mix and atmosphere (Elena and Howard, 2007; Hastreiter and Marchetti, 2016, Calvo-Porral and Levy-Mangin, 2018). However, Cristina and Jean-Pierre (2018) have found that the convenience of the shopping mall and the communication activities do not show a significant influence as pull factors.

In Malaysia, several factors have been identified related to shopping centres' characteristics that shaped shoppers' selection of their favourite shopping centres. These include aesthetics, convenience, merchandising and promotions, accessibility, architecture, atmosphere, customer service, point of difference and loyalty program, tenant mix, access convenience and ambience (Kamarulzaman and Lee, 2010; A Majid et al., 2015; Ying and Ng, 2010).

According to Lim et al (2010) and Gupta (2014), the Internet has enabled retailers to offer an unlimited range of products and services to all consumers from around the world at any point direct marketing channel for the global marketplace without any intermediary as well as simplify selling activities at a lower operating cost (Stofkova et.al, 2022). According to Wong (2019) and the earlier study by Thananuraksakul (2007), it has been highlighted that a virtual store has advantages over a brick-and-mortar store in its ability to offer consumers more choices of products/services, satisfy customers' specific needs, reduce search costs, and provide more convenient delivery & payment arrangements, time-saving, ease of use, nature of products, speed, cost-effectiveness, competitive price, and trust in online shopping. It has been highlighted that the number of online consumers is growing with its attention focused on new online marketing channels and social media platforms (Pollak et al., 2021).

Tools to model and analyse consumers' experiences in physical spaces through the customer journey map (CJM) are essential to understand the travelling order of customers before they end up buying a product. CJM enables the understanding and identification of the shoppers' expectations and desires in creating strategies that will improve their shoppers' experience at the final touchpoint as well as maps the sequence of events by a customer during an entire purchase process within a service organization (Giraldi & Bevilacqua, 2016, Rosenbaum and Ramirez, 2017, Stein and Ramaseshan, 2016). To achieve a certain shopping task, a series of touchpoints is formed within the journey of a consumer. During the purchase process, CJM lists all possible organisational touchpoints that a consumer may encounter which can be modelled with four (4) touchpoints corresponding to shoppers' arbitrage/preferences between physical and virtual spaces at the decision-making stages of their journey. The touchpoints are 1) Touchpoint 1: Making choices, 2) Touchpoint 2: Instore experience, 3) Touchpoint 3: Buying the products and 4) Touchpoint 4: Getting the products.

This study applies the concepts of customer journey and touchpoints in gathering the preferences of shoppers to the shopping platforms i.e., physical or online. Identifying the drivers of channel choice, e.g., in-store purchases or online purchases is complex and customer experience management in the context of physical and virtual spaces is a relatively new field (Verhoef et al., 2015, Lemon and Verhoef, 2016).

METHODOLOGY

This study adopted a quantitative approach to determining the preference for online shopping and shopping at shopping centres in the Klang Valley. In addition, the research model measures typical customer journeys for a consumer good purchase, a typical customer journey for a consumer good purchase (physical goods) is modelled with four touchpoints as mentioned in the earlier section.

Due to the physical contact restriction that limits face-to-face interaction as a result of the COVID-19 pandemic, an online survey was designed. In addition to having the consent to conduct the survey from the University of Malaya Research Ethics Committee (UMREC), the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) was used as a guide to improve the quality of online survey (Eysenbach, 2012). An initial advertisement through Facebook and Instagram was attempted to provide awareness and participation. After the survey appeared in these media 70,850 times, around 43,710 users were recorded to open and view the survey. Due to the poor participation, other online platforms including emails and WhatsApp were used to disseminate the survey forms (designed with SurveyMonkey) to shoppers domiciled in the Klang Valley. The use of enumerators also assisted in gathering responses from the various spectrum of shoppers who have consented to participate and fulfil the respondents' profile requirement of the targeted population in the Klang Valley. From the distributed online survey forms that were distributed, a total of 400 completed responses from the population of Klang Valley (as specified by Krejcie & Morgan (1970) for sampling size) were collected which eventually allowed for the data to be analysed accordingly.

DATA ANALYSIS

The collected data was analysed using descriptive analysis and non-parametric statistical tests using Statistical Package for Social Science (SPSS). The Descriptive analysis was used to analyse the respondents 'profiles and preferences to do shopping either online or at shopping centres. In the later section, the respondents were asked about their preferences at each of the identified touchpoints.

For the subsequent section, the survey required respondents to rank the factors that influence households to shop online or physically. The reliability test was also conducted on the result to examine the reliability of the questionnaire. In addition, the frequency of each factor was ranked with respect to the level of influence based on opinions from the respondents. This factor also was analysed using the Spearman correlation coefficient to determine if any of the factors were significantly related to each other. The Spearman correlation coefficient value ranges from -1 to 1. The higher the coefficient indicated the stronger the relationship between the variables.

RESULTS

Respondents Profile

According to Table 1, the majority of the respondents (68%) were female and 32% were male. Furthermore, most of the respondents originated from Kuala Lumpur followed by other locations in Klang Valley.

Table 1: Profile of Respondents

Respondents' Profile	Percent
Gender	
Male	32.0
Female	68.0
Shoppers Origin	
Kuala Lumpur	32.0
Petaling Jaya	9.8
Subang Jaya	8.8
Shah Alam	20.3
Other location in Klang Valley	29.3

Reliability Test

Cronbach alpha was used to measure the reliability of the items in the questionnaire. The Cronbach Alpha value of 0.693 indicates that the items have an acceptable level of consistency since the value of 0.65 and 0.95 is acceptable as specified by Chua (2006).

Shoppers Shopping Habits

Table 2 illustrates that the majority of shoppers shop in both shopping centres and online with a percentage of 93.5%. This shows that shoppers are well exposed to both shopping channels when purchasing a product.

Table 2: Percentage of shopper's shopping habits

Shopping Habits	Percent(%)
I only shop in shopping centres	4.3
I only shop online	2.3
I shop in both shopping centres and online	93.5
Total	**100.0**

Factors Influencing the Decision of Shoppers to Shop in the Physical Shopping Centre

As shown in Table 3, the factors that mostly influence the decision of shoppers to shop in the physical shopping centre are product varieties and selection (25.2%), followed by accessible location (23.7%). The third ranking factor influencing the decision of shoppers to shop in the physical centre items from the physical attributes of the shopping centre (12.9%). The lowest percentage of factors that influence the decision of shoppers is the centre branding (2.8%).

Table 3: Factors Influencing the Decision of Shoppers to Shop in the Shopping Centres

Factors of Physical Shopping	Percent (%)	Rank
Accessible location	23.7	2
Product varieties and selection	25.2	1
Products with competition pricing	10.4	5
Quality customer services	4.7	6
Physical attributes	12.9	3
Shopping atmosphere	12.5	4
Shopping centre branding	2.8	8
Recreation activities	3.8	7
Safety in the centre	3.8	7
Total	**100.0**	

Factors Influencing the Shoppers' Choice of Shopping Online

Based on Table 4, the shoppers rank convenience – anywhere, anytime (27.8%) as the most important factor affecting their choice to shop online. This is followed by time saving and ease of use which represent 21.2% and 14.7% of the total percentage respectively. The shoppers in the study sample were mainly individual shoppers, which suggests very few shoppers buy the product online in bulk (1.0%).

Table 4: Factors Influencing the Shopper's Choice of Shopping Online

Factors of On-line Shopping	**Percent (%)**	**Rank**
Convenience - anywhere, anytime	27.8	1
Time saving	21.2	2
Ease of use	14.7	3
Trust in online shopping	5.3	6
Quality of website (information and attractive)	6.9	5
Quick response to delivery	4.0	8
Safe transactions	4.4	7
Nature of products I buy - mainly cheap products	13.3	4
Nature of products I buy - mainly bulky products	1.0	10
Nature of products I buy - mainly household products	1.3	9
Total	**100.0**	

Customer Journey: Buying Physical Goods in a Shopping Centre

Table 5 shows the level of agreement of shoppers in mapping their journey when buying products through the virtual and physical space via the Four (4) touchpoints. For touchpoint 1, it was revealed that 67.8% of shoppers agree that they check retailers' websites and go to check for product choices and offers when they shop virtually while 75.8% go to the store to check the product choices when they shop at physical spaces. At touchpoint 2, 68% of the shoppers research the relevant information from the retailers' website for the product they want to buy online while 53.5% of the shoppers learn about the product from a sales representative in the store. At Touchpoint 3, 69% of the shoppers buy online while 76.1% buy instore. Finally, at Touchpoint 4, 80.6% of the shoppers get the product delivered online when they shop online while 56.3% of the shoppers collect the products in the store and bring it home.

Table 5: Level of agreement of shoppers in mapping their journey when buying products through the virtual and physical space

Mapping customer journey in virtual space and physical						
	Virtual space		Physical space			
Touchpoint 1: Making choice	I check retailers' website for product choices and offers		I go to the store to check for product choices and offers		Total	
	N	(%)	N	(%)	N	(%)
strongly disagree	15	3.8	11	2.8	26	3.25
disagree	23	5.8	21	5.3	44	5.5
neutral	91	22.8	65	16.3	156	19.5
agree	154	38.5	199	49.8	353	44.125
strongly agree	117	29.3	104	26.0	221	27.625
Total	400	100.0	400	100.0	800	100
Touchpoint 2: Instore experience	I research relevant information from the retailers' website about the products I want to buy.		I learn about products I want to buy from a sales rep in the store.		Total	
	N	(%)	N	(%)	N	(%)
strongly disagree	10	2.5	11	2.8	21	2.625
Disagree	28	7.0	61	15.3	89	11.125
Neutral	90	22.5	114	28.5	204	25.5
Agree	170	42.5	166	41.5	336	42
strongly agree	102	25.5	48	12.0	150	18.75
Total	400	100.0	400	100.0	800	100
Touchpoint 3: Buying the products	I buy online.		I buy in the store.		Total	
	N	(%)	N	(%)	N	(%)
strongly disagree	4	1.0	3	0.8	7	0.875
Disagree	11	2.8	7	1.8	18	2.25
Neutral	107	26.8	86	21.5	193	24.125
Agree	208	52.0	239	59.8	447	55.875
strongly agree	70	17.5	65	16.3	135	16.875
Total	400	100.0	400	100.0	800	100
Touchpoint 4: Getting the products	I get the products delivered.		I collect the products in the store and bring it back home with me		Total	
	N	(%)	N	(%)	N	(%)
strongly disagree	3	0.8	19	4.8	22	2.75
Disagree	11	2.8	66	16.5	77	9.625
Neutral	61	15.3	90	22.5	151	18.875
Agree	239	59.8	179	44.8	418	52.25
strongly agree	86	21.5	46	11.5	132	16.5
Total	400	100.0	400	100.0	800	100

Correlation Analysis Using Spearman Correlation Test

This test is conducted to test the correlation of the customer journey in virtual and physical space at the four touchpoints.

Table 6: Spearman Correlation Test for Touchpoint 1- Making a Choice

			I check retailers' website for product choices and offers	I go to the store to check for product choices and offers
Spearman's rho	I check retailers' website for product choices and offers	Correlation Coefficient	1.000	.206**
		Sig. (2-tailed)		0.000
		N	400	400
	I go to the store to check for product choices and offers	Correlation Coefficient	.206**	1.000
		Sig. (2-tailed)	0.000	
		N	400	400

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

A Spearman's r data analysis revealed that there is a very weak correlation, ($r = .206$, $p < .05$) between the two variables and the correlation is positive. The positive correlation shows that there is a relationship between the customers' journey in doing shopping virtually and physically when making a choice.

Table 7: Spearman Correlation Test for Touchpoint 2- Instore Experience

			I research relevant information from the retailers' website about the products I buy	I learn about products I want to buy from a sales rep in the store
Spearman's rho	I research relevant information from the retailers' website about the products I buy	Correlation Coefficient	1.000	.153**
		Sig. (2-tailed)		0.002
		N	400	400
	I learn about products I want to buy from a sales rep in the store	Correlation Coefficient	.153**	1.000
		Sig. (2-tailed)	0.002	
		N	400	400

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

A Spearman's r data analysis revealed that there is a very weak correlation, ($r = .153$, $p < .05$) between the two variables and the correlation is positive. The positive correlation shows that there is a relationship between the customers' journey in doing shopping virtually and physically for the instore experience.

Table 8: Spearman Correlation Test for Touchpoint 3 – Buying the Products

			I buy online	I buy in the store
Spearman's rho	I buy online	Correlation Coefficient	1.000	.409**
		Sig. (2-tailed)		0.000
		N	400	400
	I buy in the store	Correlation Coefficient	.409**	1.000
		Sig. (2-tailed)	0.000	
		N	400	400

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

A Spearman's r data analysis revealed that there is a weak correlation, ($r = .409$, $p < .05$) between the two variables and the correlation is positive. The positive correlation shows that there is a relationship between the customers' journey in doing shopping virtually and physically when buying the products

Table 9: Spearman Correlation Test for Touchpoint 4 – Getting the Products

			I get the products delivered	I collect the products in store and bring them back home with me
Spearman's rho	I get the products delivered	Correlation Coefficient	1.000	-0.013
		Sig. (2-tailed)		0.798
		N	400	400
	I collect the products in store and bring it back home with me	Correlation Coefficient	-0.013	1.000
		Sig. (2-tailed)	0.798	
		N	400	400

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

A Spearman's r data analysis revealed that there is no correlation, r = (-0.013) between the two variables. The correlation is also not significant with each other, $p < .05$ (which is $p = 0.798$). The negative correlation shows no relationship between the customers' journey in shopping virtually and physically when getting the products.

DISCUSSION

The survey results show that most shoppers (93% of the respondents) in the Klang Valley do their shopping at both channels i.e. at shopping centres and online. The findings revealed that the top factor is product varieties & selection followed by accessible location and physical attributes. Thus, in light of the factors mentioned in earlier studies factors identified by shoppers in Klang Valley are similar to the ones identified in past literature.

Meanwhile, the top three factors influencing Klang Valley shoppers' preference for shopping online are convenience, time saving and ease of use. This finding correlates to earlier findings by Wong (2019) insofar as virtual space has an advantage over physical space owing to its ability to offer customers convenient delivery and payment arrangements, speed, accessibility, and cost-effectiveness. With respect to their customer journeys when purchasing physical goods in a shopping centre, shoppers in the Klang Valley have varying responses to channel choices encountered during their journey in both physical and virtual spaces.

At the decision-making choice stage, i.e. at Touchpoint 1, the majority of shoppers agree that they check the retailer's website for product choices and offers while going to the physical store to check for product choices and offers. At Touchpoint 2, i.e. the instore experience, a majority of shoppers agree that they search for information on the retailers' website. Interestingly, only half of the shoppers learn about the product from a sales representative in the physical store.

At Touchpoint 3, i.e. buying the product, a majority of shoppers indicate that they buy online as well as in the physical store. At Touchpoint 4, i.e. getting the product, a majority of shoppers get their product delivered when they shop online. On the other hand, approximately half of the shoppers collect the product in physical stores. What can be observed from these findings are shoppers' preferences at the various touchpoints. Nonetheless, shoppers tend to shop in the shopping centre that they like when making purchases in physical spaces. This enhances the role of factors discussed in earlier studies of the factors as key drivers of shoppers to shopping centres.

CONCLUSION

The relationship of certain key variables, particularly those related to customer purchases either in a centre or online as a result of social media (online) and offline (shopping centre) marketing, suggests a symbiotic relationship between physical retailing (brick-and-mortar centres) and e-commerce (virtual space). To enable shopping centres to compete with online retailers, shopping centre developers/policymakers could consider a range of measures impacting the convenience of shopping centres

While it is easy to get carried away in forecasting the demise of physical space for the exclusive benefits of e-shopping, the reality on the ground is different as exemplified by the findings of this study. What e-commerce does to space is not making it irrelevant, but rather it makes it relevant in an existential rather than functional way, i.e., shoppers come to shopping centres to enjoy, meet, experience, touch, taste and feel what they might have noticed through online marketing. This positioning of retail real estate space into people's lives is an opportunity that many real estate actors are already working hard to capitalize on.

REFERENCES

Babin B.J., Darden, W.R., & Griffin, M. (1994). Work and/or fun: measuring hedonic and utilitarian shopping value. *Journal of Consumer Research, 20*(4),644-657.

Beatty, S.E., Mayer M.L., & Coleman J.E. (1996). Consumer-sales associate retail relationships. *Journal of Retailing, 72*(4), 223247.

Bloch, P.H., Ridgway, N.M., & Dawson, S.A. (1994). The consumer centres as shopping habitat. *Journal of Retailing, 72*(1), 2342

Changchit, C. (2006). Consumer perceptions of online shopping. *Issues in Information Systems, 7*(2), 177-181.

Calvo-Porral, C. and Lévy-Mangín, J.-P. (2018), Pull factors of the shopping centres: an empirical study, *International Journal of Retail & Distribution Management*, Vol. 46 No. 2, pp. 110-124.

Chang, P., Mendonça, D., & Im, I. (2004). Inside the customer: modeling cognition during online shopping. AMCIS 2004 Proceedings, 429.

Chua, Y. P. (2006). Methods and Statistics Research: Book 1 Research Methods. Kuala Lumpur: McGraw Hill

Cristina Calvo-Porral and Jean-Pierre Lévy-Mangín (2018), Pull factors of the shopping centres: an empirical study, *International Journal of Retail & Distribution Management, 46*(2), 110-124

Dixon, T. and Marston, A. (2005), "Taking the shopping centre online: new models in e- commerce", *Property Management*, Vol. 23 No. 2, 97-109.

Dixon T. and Marston A. (2002) The Impact of E-commerce on Retail Real Estate in the UK, *Journal of Real Estate Portfolio Management*, 8:2, 153-174.

Economic Planning Unit. (2015). Eleventh Malaysia Plan 2016-2020: Anchoring growth on people. Driving ICT in the Knowledge Economy, Strategy Paper 15. Putrajaya, Malaysia.

Elena, S.M., & Howard, E. (2007). Shopping for pleasure? Shopping experiences of Hungarian consumers. *International Journal of Retail & Distribution Management, 35*(6), 474-487

Eysenbach G. (2012). Correction: Improving the Quality of Web Surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). *Journal of Medical Internet Research*, *14*(1), e8. https://doi.org/10.2196/jmir.2042.

Giraldi, L., Mengoni, M., & Bevilacqua, M. (2016). *How to Enhance Customer Experience in Retail : Investigations Through a Case Study*. 381–390. https://doi.org/10.3233/978-1-61499-703-0-381

Gupta, N. (2014). Customer perception towards online shopping/retailing. jrps. in/uploads/july 2013/customer _perfection_by_nidhi_gupta. pdf.

Hasan, J (2019), E-commerce and its impact on retail stores in Slovakia, *Studia commercialia Bratislavensia, 12* (41). 16-23

Kamarulzaman, Y., & Lee, F. C. L. (2010). Attracting shoppers to shopping centres: The Malaysian Perspective. *Interdisciplinary Journal of Contemporary Research in Business, 2*(3), 185-198

Kirkup, M.H. and Rafiq, M. (1999), "Marketing shopping centres: challenges in the UK context", Journal of Marketing Practice: Applied Marketing Science, Vol. 5 No. 5, pp. 119-133. https://doi.org/10.1108/EUM0000000004570

Krejcie R V & Morgan D W (1970), Determining Sample Size for Research Activities, *Educational and Psychological Measurement*, 30, 607-610

Lund, C. (2020). The Effects of E-commerce on Retail Property Values: A study about how the growth of e-commerce affects property values in the retail real estate sector (Dissertation). Retrieved from http://urn.kb.se/resolve?urn=urn:nbn:se:kth:diva-277028

McGowan, Jacob, "How Has the Growth of E-commerce Sales Affected Retail Real Estate?" (2019). CMC Senior Theses. 2189. https://scholarship.claremont.edu/cmc_theses/2189

NAPIC, Property Market Report, 2022

Razali N., Rahman A., Adnan M.Y., Yassin M. (2014) The impact of information and communicating technology on retail property in Malaysia, *Property Management*, 32:3, pp. 193-212.

Rohayu Ab Majid, Nor Zalika Adnan, Rosli Said, Olusegun Olaopin Olanrele (2015), Drivers Influencing Customers' Visit to Shopping Centres in Malaysia, *International Surveying Research Journal (ISrJ), 5*(3), pp.43-10

Rosenbaum, M. S., Otalora, M. L., & Ramirez, G. C. (2017). *How to create a realistic customer journey map*. *60*, 143–150. https://doi.org/10.1016/j.bushor.2016.09.010

Savills Commercial Research, Retail 2018, Retail Revolutions Exploring the impact of E-commerce on Local Physical Retailing. Retrieved from: https://savills.co.uk/insight-and-opinion

Statista : https://www.statista.com/outlook/243/122/ecommerce/malaysia).

Stein, A., & Ramaseshan, B. (2016). Towards the identification of customer experience touch point elements. *Journal of Retailing and Consumer Services*, *30*, 8–19. https://doi.org/10.1016/j.jretconser.2015.12.001

Thananuraksakul, S. (2007). Factors influencing online shopping behavior intention: A study of Thai consumers. *AU Journal of Management, 5*(1), 41-46.

Verhoef, Peter & Kannan, P. K. & Inman, J.. (2015). From Multi-Channel Retailing to Omni-Channel Retailing. *Journal of Retailing*. 91. 10.1016/j.jretai.2015.02.005.

Wong, Xian Yang (2019), Impact of Technology on the Singapore Retail Market, Cushman & Wakefield, Retrieved from: https://www.cushmanwakefield.com/en/singapore/insights/blog/impact-of-technology-on-the-singapore-retail-market

Received: 7th June 2023. Accepted: 5th September 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 387 – 401

APPLICATION OF COCONUT COIR MATTING AND VEGETATION FOR RIVERBANK EROSION PROTECTION

Naqib Azfar Azmi[1], Saerahany Legori Ibrahim[2], Izihan Ibrahim[3], Dani Irwan Masbah[4,] Siti Asmahani Saad[5]

[1,2,3,4,5]*Kulliyyah of Engineering,*
UNIVERSITI ISLAM ANTARABANGSA MALAYSIA

Abstract

In this paper, a sustainable and non-structural solution is identified to solve the problem of riverbank erosion by using the case study of Pusu River in the district of Gombak, Selangor, Malaysia. Several types of non-structural and sustainable materials were used as riverbank protection in the study area with the application of coconut coir mat and vetiver grass and their effectiveness were evaluated. The coconut coir was fabricated in the laboratory as per ASTM D6525 and it was applied in four plots at the riverbank that consist of different configurations namely bare soil, coconut coir mat with natural vegetation, coconut coir mat with vetiver grass, and vetiver grass on its own. To analyse the effectiveness of the configurations, two tests such as visual inspection test and riverbank erosion assessment using erosion pins were conducted. This study concludes that coconut coir helps vetiver grass roots to grow more expansively as compared to the growth of the vetiver grass without coconut coir. The application of vetiver grass is proven to be 90.5 % effective which is higher than other types of configurations with a 0.05 cm/day mean erosion rate observed.

Keywords: coconut coir, erosion pin, riverbank erosion, vetiver grass

[2] Assistant Professor Email: saerahany@iium.edu.my

INTRODUCTION

River rehabilitation and restoration is not entirely new, as it has been practiced since a century ago (Bischetti et al., 2012). A great variety of strategies have been made across the world to restore the natural watercourse in their places, particularly which have been damaged due to natural disasters such as floods as well as anthropogenic intervention. Anthropogenic activities are still polluting the rivers in many countries, including Malaysia (Firdaus, Rasidi and Said, 2021). Since water is considered as one of life source, a serious attention on the activities that lead towards damaging this natural watercourse should be controlled to a minimum level (Tun Ismail et al., 2023). Nevertheless, a sustainable strategy towards the restoration of the riverbank is of great interest nowadays. There are numerous methods of riverbank protection designed throughout the years. Most of the river protection designs invented are conventional methods applying structural components such as reinforced concrete and steel structures.

At this present moment, it is crucial to produce a more sustainable design as it is more environmentally friendly and cost-effective in comparison to conventional designs. Nevertheless, in order to solve the problem, a sustainable solution is important where there must be a balance in environmental, social and financial aspects (Mickovski, 2016). It is proven that the soil bioengineering approach is an option that meets the requirements of technical and environmental concerns as there is a significant number of technical literatures on the subject produced in the preceding decades (Bischetti et al.,2012).

Despite the various methods of implementing riverbank protection available, it is important to make a proper selection of methods that can be implemented to avoid consequences such as excessive protection and redundant structures (Islam, 2008). The author also stated that riverbank protection built to protect a single point can also have an impact on the others points downstream.

The proposed method adopted in this study covers a series of sustainable strategies and designs from past researchers in producing a design that will help to solve the riverbank erosion in the study area. Types of materials and riverbank protection designs are produced by considering the cost, effectiveness, and sustainability features. Other than that, a physical scale model that is used for a procession of test runs is constructed in order to justify the effectiveness and the efficiency of the proposed design.

LITERATURE REVIEW

Riverbank Erosion

It is important to acknowledge the definition of riverbank erosion based on the types, characteristics and morphology of the riverbank before looking into possible methods to be implemented as riverbank protection measures (Islam, 2008). Collell et al. (2017) highlighted that engineering approaches are important to be implemented, as natural processes alone such as riparian vegetation are unable to withstand the present soil erosion problem. The authors also categorized the methods of protection into three categories which are conventional engineering, bio-engineering and compound solution that include structural and non-structural methods.

Riverbank erosion can be defined as the motion of the soil and sediment at the bank or bed of a river due to various causes, which may be due to the flow of the water, land use or weathering. Islam (2008) claims that the bank erosion phenomenon is a process that is repeated in sequences and that there are four sub-processes involved, which are abruption of riverbank slopes, slipping of the unstable slope, discharging of the failed soil of the slipping slope to the riverbed and lower part of the slope and the riverbank becoming unstable. This cyclic process is influenced by two main factors, which are hydraulic instability and geotechnical instability.

Soil erosion can be classified into two categories which are geological erosion and accelerated erosion (Abidin et al., 2017). Geological erosion is a natural phenomenon as the earth basically moves but the movement is not significant and the process requires a long period of time. This movement is actually a process to stimulate the formation of soil to be in an equilibrium state (Abidin et al., 2017). The authors also explained accelerated erosion which is a phenomenon where the soil moves because of the removal of vegetation that support the soil formation. Therefore, it is important to adopt appropriate riverbank protection measures in solving the issue of riverbank erosion.

Bio-Technical Riverbank Protection

Bio-technical engineering is a combination of geotechnical and bio-engineering disciplines that include vegetative and non-vegetative structural components (Morgan & Rickson, 1995). Similarly, Collell et al. (2017) states that artificial or natural material can be applied to bio-engineering measures in order to provide more structural stability.

On top of advantages of vegetation methods, especially its self-regeneration and soil stabilization improvement capability, bio-technical engineering also provides many equal opportunities to the economy, society, and nature aspects (Mickovski, 2016; Mickovski & Thomson, 2017). This type of approach is aligned with as sustainable development in which nature is not left behind while constructing a reliable, stable and durable structure with many precautions related to the sustainability of the environment, such as preserving natural life, minimizing waste and utilizing resources to the fullest (Mickovski, 2016).

Coconut Coir Matting

The scientific name of coconut is *Cocos Nucifera*. It is a fruit that has the thickest fiber strain among all types of natural fibers (Thyavihalli Girijappa et al., 2019).

The coconut coir is suitable to be a coir mat because of its properties of being a renewable resource, cost-efficient, highly water absorbent and full of nutrients that can support vegetation growth (Verma & Gope, 2015).

Jaafar et al. (2020) stated that erosion control matting can provide many significant advantages as the mat not only help to protect the surface runoff due to rainfall at the riverbank but also helps to cover the vegetation which increases the stability of the riverbank. The authors also stated that the mats can be made of natural materials such as fibers, wood or straw. On top of that, Jaafar et al. (2020) also conducted a case study in which coconut coir was utilised as a protective measure on the slope to minimize the effect of water erosion. It was proven that coconut coir matting helps vegetation development and provides extra reinforcement on the soil as the shear strength of the soil is increased. A case study by Jaafar et al. (2020) has proven that planting vegetation with matting shortens the length of the vegetation root while simultaneously increasing the concentration of the said root. This phenomenon also improves the stability of the riverbank soil.

Application of Vetiver Grass

Vetiveria Zizanioides or more commonly known as vetiver grass was promoted in 1980 by the World Bank as a land conservation measure in India (Leknoi & Likitlersuang, 2020). The authors also further discussed that Vetiver grass is highly functional where it is beneficial in various applications such as agriculture, slope stabilization, land mining, wastewater treatment and contaminated land rehabilitation. Moreover, the authors also described a few special characteristics to vetiver grass that are not exhibited by other vegetation, namely strong and fibrous roots that can penetrate soil approximately 2 or 3 meters per year, high tolerance to the extreme weather conditions such as flood and drought due to its survivability.

A slope profile simulation with and without vetiver grass were done in Malaysia to compare the slope factor of safety concluded that the application of vetiver grass is highly effective in order to provide protection to the slope without considering the its angle as shown in Figure 1 (Mohd Taib et al., 2020). Moreover, vetiver grass is proven to be more affordable and cheaper (Mondal & Patel, 2020). In addition, the authors state that the combination of vetiver grass with other protection measures has the potential to produce long-term riverbank conservation.

Selection of Riverbank Erosion Protection Strategies

Riverbank protection measures can be divided into three categories which are conventional hard structural, non-structural, and mixed methods (Collell et al., 2017). This study focuses on the non-structural method with the addition of sustainable features, which is a method that is more considerate to the environment with the use of organic materials and involving minimum alteration to the natural structure of the riverbank. In addition to that, two types of techniques have been shortlisted as the potential sustainable protection measures, which are bamboo planting and application of coconut coir mat.

It can be concluded that the application of coconut coir mat is more feasible than planting bamboo for a few reasons, chief of which it takes a lot of time for the growth of the bamboo plant. Based on research by Pertiwi et al. (2021), the result of bamboo planting can only be obtained after three to five years after planting. On the other hand, the application of coconut coir mat only takes less than a month just to observe the growth rates of the vegetation in the model (Jaafar et al., 2020).

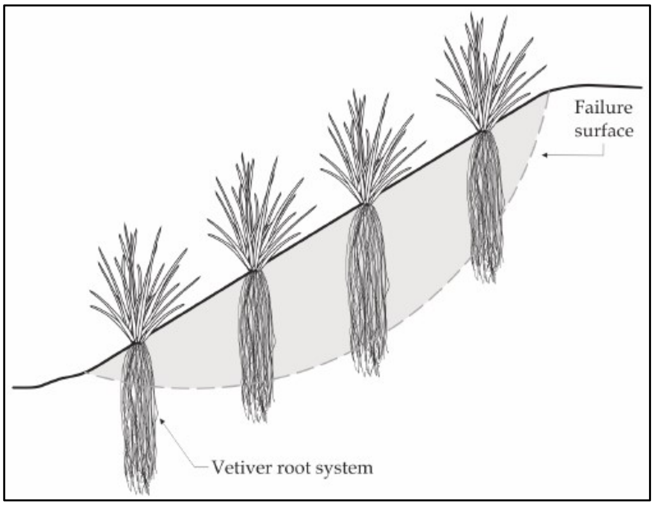


Figure 1: Application of vetiver grass as slope protection.
(Mohd Taib et al., 2020).

RESEARCH METHODOLOGY

Initially, a site investigation was carried out in order to attain associated data and parameters regarding the main problem occurring in the study area. The design of the riverbank protection for this study involves the application of coconut coir mat. On top of that, fabrication of coir mat and samples preparation were done. There were four types of configurations namely bare soil, coconut coir mat with natural vegetation, coconut coir mat with vetiver grass, and vetiver grass on its own. Testing of application and fieldwork data collection includes visual inspection test, riverbank erosion assessment using erosion pin and soil test. Based on the qualitative and quantitative data obtained, further analysis and discussion were done to justify the objective of this study.

Site Investigation and Materials Selection

One of the earliest stages of this study consists of conducting several site visits to assess the location of the study area and to collect data. The location of the study area is the downstream part of Pusu River as illustrated in Figure 2. Additionally, the Pusu River is one of the tributaries of Gombak River and it is the biggest watercourse in Gombak District. However, upstream of the Pusu River, many activities take place that have a negative impact on the Pusu River ecosystem including illegal construction, illegal logging and illegal farming.

Figure 2: The aerial view of Pusu River

Based on the visual inspection conducted, it can be concluded that Pusu River is facing sedimentation problems and riverbank erosion. The riverbank erosion is majorly due to hydraulic instability as the flow of the river and the volume of water are decreasing gradually due to the high sedimentation concentration in the river.

A site visit was also conducted to assess the river geomorphological condition to identify the location of the riverbank erosion. The types of riparian vegetation which naturally exist on the riverbank at Pusu River are *Ludwigia Alternifolia* and common natural grass. Some other parts of the riverbank were observed to be without vegetation (Hambal, 2021).

The selection of vetiver grass with coconut coir matting is due to other factors, as well such as the cost of the material. Vetiver grass is commercially used in many industries in Malaysia, and the cost is considered affordable, at around RM 4.80 per polybag. Not only that, the coconut coir is made of coconut husk, which is considered to be an abundant waste product of the agriculture industries in Malaysia. Due to this fact, it is cheap to acquire the coconut coir. In addition, the selection of material is also influenced by the serviceability of the protection measure. In this case, both of the materials did not require much maintenance as the coconut coir and vetiver grass are considered strong in other to withstand extreme conditions such as drought and flood. Thus, due to the short study period of this project, setting up a test model for a coconut coir mat with the planting of vetiver grass is the best method that is sustainable and not involving artificial structural components.

Fabrication of Coconut Coir

Coconut coir mat can be easily obtained as it is commercially available. In this study, coconut coir mats were fabricated in Kulliyyah of Engineering laboratory using Compression Testing Machine, as shown in Figure 3, with reference to ASTM D6525: Standard Test Method for Measuring Nominal Thickness of Rolled Erosion Control Products.

Procedure of Fabricating Coconut Coir Mat

The first step of fabrication is to extract the coconut husk to turn it into the coconut coir. This process was done by splitting and peeling the coconut husk from the pith in order to get a fibrous state of coconut coir which is easier to mould and shape. The coconut coir obtained from the previous process is heated in the drying oven at a temperature of 160°C for 5 minutes to complete the process of the extraction as shown in Figure 4.

Figure 3: Compression Testing Machine

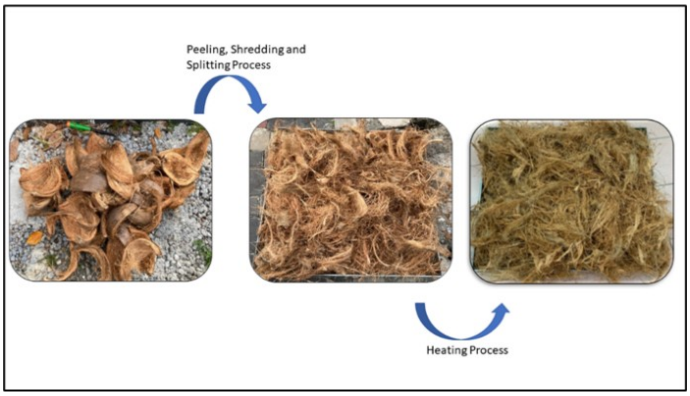


Figure 4: Extraction process of coconut coir

The process continues to the fabrication of coconut coir mat by pressing the coconut coir using Compression Testing Machine for 10 minutes with 6 kN pressure in order to fabricate with a thickness of 6 mm as per ASTM D6525: Standard Test Method for Measuring Nominal Thickness of Rolled Erosion Control Products. The coconut coir is fabricated using Aggregates Crushing Value Mould and prepared using a special method in order to produce the coconut mat in the most efficient manner and applicable to the Compression Testing Machine as shown in Figure 5.

Sample Preparation

The test model was conducted in the study area and will be categorized into four configurations which are:

1. Bare soil.
2. Soil with natural vegetation on the riverbank with coconut coir matting.
3. Soil with the addition of vetiver grass with coconut coir matting.
4. Soil with the addition of vetiver grass planted independently.

The vetiver grass was selected due to its characteristic of having a long root system that can be a structural component of the soil. In this study, the planting techniques do not involve hydroseeding as it may cause many uncertain scenarios, such as the availability of the seeds and the failure of the seedling stages. Hence, vetiver saplings were used at this stage. The test model also involved natural vegetation that already exists in the riverbank area. The grass in the surrounding area underwent replanting when the coconut coir mat was installed. Finally, in order to prepare soil without vegetation, a section of the test site needs to be cleared of any vegetation prior to coconut coir mat installation.

Figure 5: Fabrication of coconut coir

Testing

Visual Inspection Test

The visual inspection test was performed in order to observe the effects of installing coconut coir mats on the vegetation in the four conditions. The characteristics of the vegetation roots were observed once weekly for three months. This procedure is important in order to justify whether combining coconut coir mats with vegetation helps to improve the growth rate of the vegetation. Photographic images were taken as an observation to compare each different condition which also includes the growth of vegetation roots and the overall condition of the test.

Riverbank Erosion Assessment Using Erosion Pin

Erosion rates were observed by using erosion pins installed at all four plots. This assessment method will give a more precise detail of whether the coconut coir mat can provide additional support to the soil of the riverbank or otherwise. 28 pins were inserted in a horizontal alignment approximately 30.4 cm deep in the soil sample. Measurements from the tip of the pins to the riverbank surface were taken at regular intervals from April to June 2022.

ANALYSIS AND DISCUSSION

Visual Inspection Analysis

Figure 6 shows the visual comparison of the vetiver grass root observation at initial condition taken on 19 April 2022 and its final condition taken on 2 June 2022. From the observation, it can be seen that vetiver grass roots with coconut coir grew more expansively compared to those without coconut coir. This finding could be attributed to the application of coconut coir seemingly being beneficial to the growth of vetiver grass roots. This is in agreement with Jaafar et al. (2020) where coconut coir matting helps vegetation development and provides extra reinforcement on the soil.

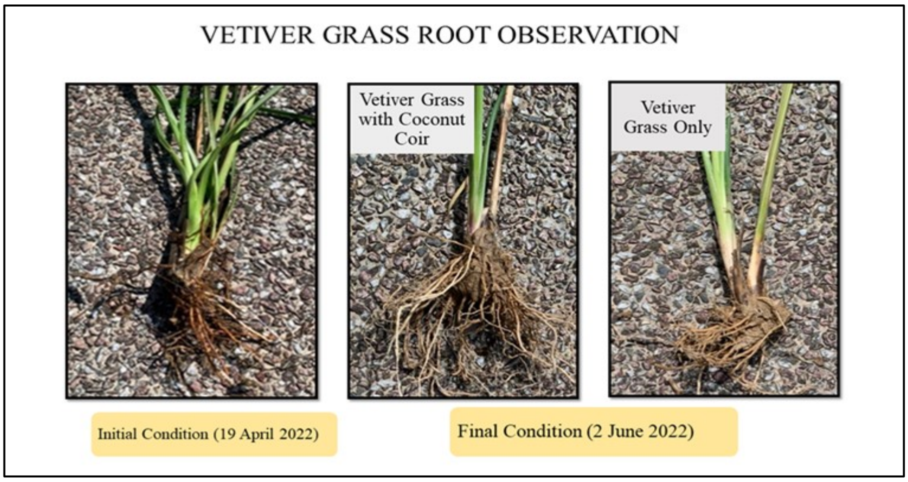


Figure 6: Vetiver grass root visual observation

Erosion Pin Assessment

In this erosion pin data assessment, the mean of the erosion rates for every plot, the percentages difference of the effectiveness of each method with respect to the average of the mean erosion rates, and the spatial variation of each pin will be discussed. All of these results are pertinent in terms of justifying the effectiveness of the suggested sustainable solution for riverbank erosion.

Mean Value for Erosion Rates

The mean value of the erosion rates for every plot is calculated to exhibit the riverbank erosion that has occurred. The mean value for erosion rates of each plot is calculated by averaging the exposed length for each pin divided by the number of data collection days. The mean value of erosion rates for every plot is shown in Figure 7. The highest mean of erosion rates was exhibited by the bare soil plot, which is 0.0818 cm/day, and the lowest is in vetiver grass with coconut coir plot which is 0.0360 cm/day. Therefore, it is proven that vetiver grass with coconut coir is the most effective in protecting the riverbank from erosion, followed by the natural vegetation with coconut coir (0.0461 cm/day) and vetiver grass installed independently (0.0502 cm/day).

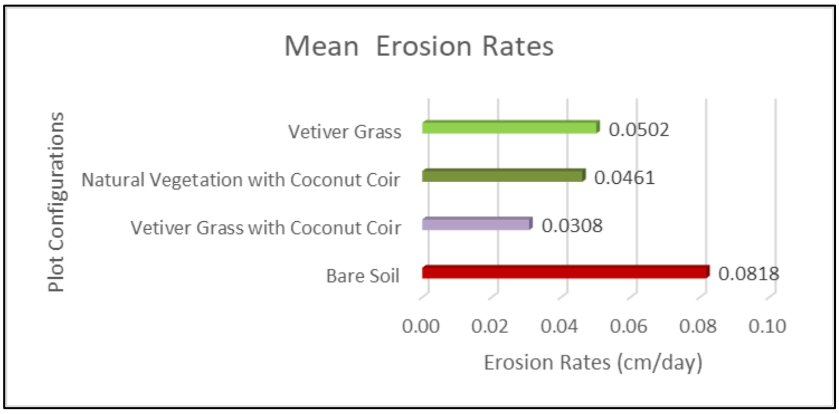


Figure 7: Tabulation of erosion rates mean value

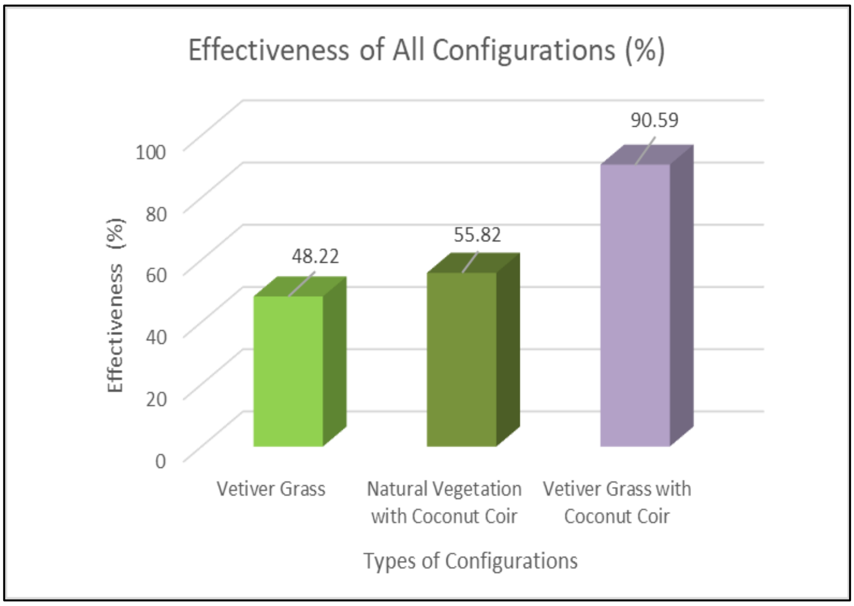


Figure 8: Effectiveness of all condition types to reduce erosion rates

The output of the mean values for erosions of each plot could also be represented in terms of effectiveness expressed as percentage difference of the mean erosion rates of the various configurations against that of bare soil.

Results show the highest percentage of effectiveness was obtained for the configuration of vetiver grass with coconut coir at 90.59% as compared to its counterparts shown in Figure 8. Ultimately, this indicates the application of vetiver grass with coconut coir matting is proven to be the most effective solution to treat the riverbank erosion at the Pusu River.

Spatial Variation of Erosion Value

In order to provide a different perspective of the erosion that occurred at the riverbank, spatial variation of erosion values at each pin was introduced. This erosion value denotes the change of the exposed length of the pin from the beginning to the end of the observation period. In Figure 9, the magnitude of this change is represented by the size of the circle.

The bare soil plot demonstrated the biggest change of erosion value compared to other types of configurations, which exceeds 10 cm at the toe of the plot. Conversely, the lowest change of erosion value was exhibited by the vetiver grass with the coconut coir configuration followed by natural vegetation with coconut coir, vetiver grass only and lastly the natural grass on its own.

Figure 9 also demonstrated that the erosion majorly happened at the toe of each plot. However, the proposed method, which is the application of the vetiver grass with coconut coir, still provides good protection as it lessens the change in measurement at the toe of the riverbank.

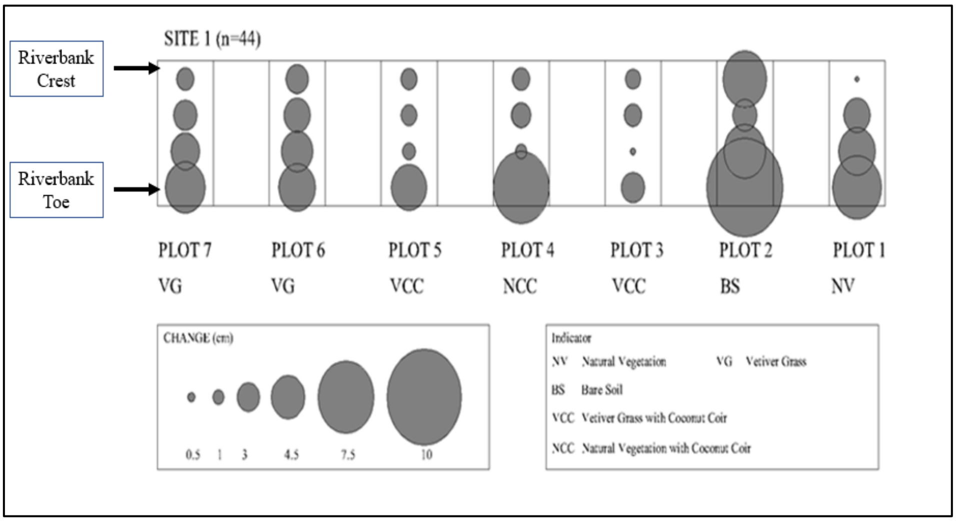


Figure 9: Spatial variation of all configuration

CONCLUSION

This research has succeeded in applying and evaluating the efficiency of various configurations of sustainable materials and vegetation for the purpose of riverbank protection measures in Pusu River. Coconut coir and vetiver grass were selected specifically for this study considering the cost, effectiveness, and sustainability features. Field observation and measurements were successfully conducted for four different plots consisting of bare soil and the other configurations which are coconut coir mat with natural vegetation, coconut coir mat with vetiver grass, and vetiver grass alone.

The configuration of coconut coir mat and vetiver grass is proven to provide the best result in terms of providing effective protection toward the riverbank as evidenced by 0.308 cm/day erosion rate, 90.59% efficiency and lowest magnitude of change in erosion value. Furthermore, with regards to root morphology, results show that the configuration of vetiver grass and coconut coir achieved the best outcome in which the vetiver grass roots have grown more expansively compared to other configurations. These findings suggest that this configuration enhances the soil strength therefore leading to better riverbank stability. Future study can be undertaken on other parameters that includes hydraulic, geotechnical and bio-engineering aspects to further enhance the efficiency of non-structural and sustainable riverbank protection measure.

ACKNOWLEDGEMENTS

This research was financially supported by IUM Flagship Research Initiative Grant Scheme (IRF) Research Project IRF19-017-0017 entitled "Sedimentation and Total Maximum Daily Load (TMDL) Analysis of Sungai Pusu, IIUM Gombak Campus".

REFERENCES

Abidin, R., Sulaiman, M., & Yusoff, N. (2017). Erosion risk assessment: A case study of the Langat River bank in Malaysia. *International Soil and Water Conservation Research, 5*(1), 26-35. https://doi.org/10.1016/j.iswcr.2017.01.002

Bischetti, G., Di Fi Dio, M., & Florineth, F. (2012). On the Origin of Soil Bioengineering. *Landscape Research, 39*(5), 583-595. https://doi.org/10.1080/01426397.2012.730139

Collell, M., Hooke, J., Escarameia, M., Gimeno, O., de Vilder, L., & Simm, J. et al. (2017). *Green approaches in river engineering* (1st ed.). HR Wallingford Ltd

Firdaus, R. M., Rasidi, M. H., & Said, I. (2021). Components of River Sustainability Through Community's Experiences in Riverside Neighbourhood. *Planning Malaysia, 19*(15). https://doi.org/10.21837/pm.v19i15.926

Holanda, F., & Rocha, I. (2011). Streambank Soil Bioengineering Approach to Erosion Control. Progress In Molecular and Environmental Bioengineering – From Analysis and Modeling to Technology Applications

Islam, (2008); Riverbank Erosion Protection Strategies. In: Sekiguchi, Hideo (Hg.): *Proceedings 4th International Conference on Scour and Erosion (ICSE-4)*. November 5-7, 2008, Tokyo, Japan. Tokyo: The Japanese Geotechnical Society. S. 316-323

Jaafar, A., Rahman, M., Jeni, M., Osman, M., Awang, Z., & Abdullah, M. et al. (2020). Coconut Coir Mat for Slope Vegetation. *Advances In Engineering Research*, 200, 281-285. https://doi.org/10.2991/aer.k.201229.036

Leknoi, U., & Likitlersuang, S. (2020). Good practice and lesson learned in promoting vetiver as a solution for slope stabilization and erosion control in Thailand. *Land Use Policy*, 99. https://doi.org/10.1016/j.landusepol.2020.105008

Morgan, R., & Rickson, R. (1995). Slope Stabilization and Erosion Control: A Bioengineering Approach (1st ed.). Chapman & Hall.

Mickovski, S. (2016). Why is the future ready for environmental geotechnics *Environmental Geotechnics, 3*(2), 63-64. https://doi.org/10.1680/envgeo.13.00107

Mickovski, S., & Thomson, C. (2017). Developing a framework for the sustainability assessment of eco-engineering measures. *Ecological Engineering*, 109, 145-160. https://doi.org/10.1016/j.ecoleng.2017.10.004

McMahon, J., Olley, J., Brooks, A., Smart, J., Stewart-Koster, B., & Venables, W. et al. (2020). Vegetation and longitudinal coarse sediment connectivity affect the ability of ecosystem restoration to reduce riverbank erosion and turbidity in drinking water. *Science Of the Total Environment,* 707. https://doi.org/10.1016/j.scitotenv.2019.135904

Mohd Taib, A., Abd Rahman, N., Taha, M., Mat Yazid, M., & Khoiry, M. (2020). THE EFFECT OF SOIL-ROOT INTERACTION BY VETIVER GRASS ON SLOPE STABILITY. *Journal Of Engineering Science and Technology* Special Issue On 5Th International Technical Conference 2016, 46-57.

Pinto, A., Fernandes, L., & Oliveira Maia, R. (2018). A method for selecting suitable technical solutions to support sustainable riverbank stabilization. *Area, 51*(2), 285-298. https://doi.org/10.1111/area.12488

Ranjan, V., Sen, P., Kumar, D., & Sarsawat, A. (2015). A review on dump slope stabilization by revegetation with reference to indigenous plants. *Ecological Processes, 4*(1). https://doi.org/10.1186/s13717-015-0041-1

Thyavihalli Girijappa, Y., Mavinkere Rangappa, S., Parameswaranpillai, J., & Siengchin, S. (2019). Natural Fibres as Sustainable and Renewable Resource for Development of Eco-Friendly Composites: A Comprehensive Review. *Frontiers In Materials*, 6. https://doi.org/10.3389/fmats.2019.00226

Tun Ismail, W. N. A., Amin, A., Kamarudin, M. K. A., Ibrahim, A., & Nik Md Salleh, N. S. (2023). Community Concerns of River Pollution Spatial Model using Geographic Information System (Gis) In Ibai River, Terengganu. *Planning Malaysia*, *21*(25). https://doi.org/10.21837/pm.v21i25.1226

Verma, D., & Gope, P. (2015). The Use of Coir/Coconut Fibers as Reinforcement in Composites, *Biofiber Reinforcement in Composite Materials*, 285-319. http://doi.org/10.1533/9781782421276.3.285

Received: 24th July 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 402 – 413

LAND SUITABILITY ANALYSIS FOR URBAN GARDENING USING GIS-BASED MULTI-CRITERIA DECISION-MAKING APPROACH

Zulkifli Ahmad Zaki[1], Mohammad Yusup[2], Ishak Che Abdullah[3], Yusfida Ayu Abdullah[4] & Aqeel Shah Abdul Halim Shah[5]

[1,2,3,4,5]*Kolej Pengajian Alam Bina,*
UNIVERSITI TEKNOLOGI MARA, MALAYSIA

Abstract

The application of the Geographical Information System (GIS) extends beyond mapping and includes an analysis of attribute and geographical data, identification of behavioural patterns, and visualisation of positional analysis outcomes. The system provides accurate coordinates, enabling functions such as storage and retrieval, pattern search, and model creation in GIS applications. One widely adopted approach for land-use identification involves utilising GIS operations to establish databases and conduct analyses. Thus, this study utilises ArcGIS software tools to determine the suitability of land and optimal location for the development of community gardens in Shah Alam. Decision-making was based on multiple criteria, and to ensure accurate and comprehensive data, the researchers employed a qualitative method similar to expert interviews. Related government agencies and authorities, as well as experts, provided input through three separate expert interviews. Findings from the interviews highlighted the significance of land slope, elevation, land use, proximity to settlements, road accessibility, and water access as important considerations for site selection in urban gardening or community gardens. The study demonstrates the effectiveness of GIS methods in obtaining such results and recommends that future research focus on assessing the potential for sustainable development by leveraging GIS techniques.

Keywords: Multi-criteria Decision Making, Land Suitability, GIS, Urban Gardening

[1] Lecturer at Universiti Teknologi MARA. Email: zulkifliahmadzaki@uitm.edu.my

INTRODUCTION

Known as urban farming, urban gardening involves growing plants and crops in urban areas, often in small-scale and limited spaces such as balconies, rooftops, or community gardens. Urban gardening plays a significant role in improving food security, particularly for vulnerable and underprivileged communities with limited access to fresh and affordable produce. In Malaysia, people in urban areas typically rely on local supermarkets and wet markets for their food, including vegetables. According to the Food and Agriculture Organization of the United Nations (FAO, 2022), people living in urban areas in Malaysia usually obtain their food supplies, especially vegetables, from local supermarkets and wet markets. Although the country has enough food supply, the FAO has cautioned about the possible difficulties in accessing food, particularly during disasters. Urban gardening can address these issues by increasing food availability and access, thus supporting food security for Malaysia's urban population.

Sustainable urban farming, including urban gardening, is an approach aimed at enhancing food security by increasing food supply and access. However, urban farmers in Malaysia (particularly those in major cities such as Kuala Lumpur, Shah Alam, and Johor Bharu) have faced various challenges. These include limited and suitable land access, water availability, difficulties in accessing financial institutions, lack of commitment, and administrative policies and bureaucracy involving multiple authorities (Ishak, Norziha, et al., 2022). Rapid developments in the urban and suburban regions are limiting the amount of land and green spaces available for recreational and social activities. This expansion has significant repercussions for the ways in which local communities, particularly urban farmers, are involved in the food resources business directly or indirectly. Additionally, the development of community gardens without systematic management can result in a less appealing and conducive urban environment. As a result, multiple guidelines for the establishment of community gardens and urban farming have been issued by various agencies.

The comprehensive and forward-thinking implementation of these guidelines can be further enhanced through the use of a GIS-based Multi-Criteria Decision Making (MCDM) approach. The application of this MCDM method is not limited to a small number of disciplines. It can be used to determine and comprehensively analyse the suitability of land for the development of beneficial and sustainable urban gardening. GIS-based multi-criteria decision analysis is the most common method for agriculture land suitability (Ozsahin, E., & Ozdes, M., 2022). By analysing multiple criteria such as soil type, soil texture, soil thickness, slope, climate properties, and soil structure, land suitability maps can be generated and used as a valuable tool for land use management.

LITERATURE REVIEW

Urban Gardening and Community Garden

Community gardens are often associated with the revitalisation of urban lands through neighbourhood beautification and restoration (Mccormick, K., 2020). These gardens are located in public spaces or commonly-held land and shared, particularly in an urban setting. Community gardens can be found in several locations, ranging from urban, suburban, and rural areas. They may vary in size, ranging from a few small plots to several acres. The crops planted in community gardens can vary depending on climate, location, and community preferences. Short-term crops such as herbs, leafy greens, and radishes (Zaidi Tajuddin, 2019) are well-suited for urban gardens due to their fast-growing nature, making them suitable for limited spaces and shorter growing seasons. Regarding the suitability of soil type, a few options can be considered, such as container potting mix, raised bed soil, or hydroponic and aquaponic systems. However, it is important to note that the suitability of soil types and crop choices can vary depending on the unique settings of urban gardening, such as the amount of sunlight and water available, as well as the prevailing climate.

Community gardens and urban gardens are typically managed by local residents or civic organisations in the surrounding area. These garden managers may charge minimal fees or solicit volunteer labour (Delshad, A. B., 2022) in exchange for providing access to garden plots and utilities, such as water, composting, and shared tools. Urban gardening offers numerous benefits, including increased access to fresh and healthy food, promotion of physical activity and overall health, fostering social connections, providing valuable educational opportunities, enhancing property values while reducing crime rates, enhancing biodiversity, and contributing to overall environmental improvement (DeMuro, 2021).

Multi Criteria Decision Making Approach (MCDM)

Multi-Criteria Decision Making (known as MCDM) is a method that facilitates informed decision-making when multiple criteria need to be considered or when there is a need to choose among alternatives in which the selection of the most appropriate option is extremely complex (Dehe, B., & Bamford, D., 2015). The method allows for the integration of geographic data and value judgements to assess decision alternatives. GIS-based multi-criteria decision-making is particularly beneficial for complex land-use decision support as the tool offers solutions to various spatial issues.

Analytic Hierarchy Process (AHP)

Developed by Thomas L. Saaty in the 1970s, Analytic Hierarchy Process (AHP) is a widely used method for decision making in numerous fields, including engineering, finance, transportation and environmental as well as economic land suitability assessment. AHP involves defining objectives, criteria, and alternatives, and then evaluating the relative importance of each criterion and alternative using pairwise comparisons (Saaty, T. L., 1980). This allows decision-makers to incorporate trade-offs between criteria and alternatives. AHP provides a structured approach, flexibility, and the ability to incorporate subjective judgments, making it a suitable method for community garden site selection (Yang, Fang, & Lai, 2017).

METHODOLOGY

This study employed different methods to establish the criteria for community urban garden site selection, determine the most suitable location, and produce a land suitability map. The approaches used include i) descriptive analysis to establish criteria for urban garden site selection; ii) AHP to determine the most suitable area; and iii) spatial analysis to produce a land suitability map indicating suitable areas for urban gardening. AHP is a methodological approach which implies structuring criteria of multiple options into a system hierarchy (Omkarprasad S. Vaidya, 2006), including relative values of all criteria, comparing alternatives for each particular criterion, and defining the average importance of alternatives (Ivan Pogarčić, Miro Frančić, Vlatka Davidović, 2008). The results of the study can be used to identify and assess appropriate land and suitable location for urban gardening, and policymakers can take necessary steps to ensure the sustainability of urban farming initiatives while planning for other development.

Method of Data Collection

This study utilises a set of collected data through open-source databases and related agencies such as the local authority and municipalities. The secondary data contains the current land use data for the District of Petaling, particularly Shah Alam, encompassing roads, industrial areas, commercial areas, residential areas, green areas, forests, water bodies, and infrastructure, as well as raster data containing slope and elevation information.

Expert Interviews

Structured and in-depth interviews were conducted with representatives from the local authority (Majlis Bandaraya Shah Alam) and a town planner with professional certification and more than ten years of experience in GIS application and spatial planning. Three (3) experts were interviewed to obtain exclusive insight regarding the validation and verification of the selected criteria for determining the site suitability for a community garden. A series of structured questions were presented and answers were recorded through scores and notes.

The questions were divided into two sections. The first section involved a scoring component where each expert was asked to provide scores ranging from 1 (Not Suitable) to 4 (Most Suitable) and rank the criteria used in selecting the community garden site (Table 1). The second section aimed to gather general insights from the experts regarding their views on the given criteria. The validation of criteria through expert opinions is influential as these experts possess a comprehensive understanding of the criteria selection process and its impact on site selection.

Table 1: Criteria validation for community garden site selection

No.	Criteria	Sub-Criteria	Suitability	Score
1	Slope	<15º	Most Suitable	4
		16º - 25º	Suitable	3
		26º - 35º	Less Suitable	2
		>35º	Not Suitable	1
2	Elevation	<150m	Most Suitable	4
		150m – 300m	Suitable	3
		300m – 1000m	Less Suitable	2
		>1000m	Not Suitable	1
3	Land use	Vacant Land	Most Suitable	4
		Agriculture	Suitable	3
		Open space and recreational	Less Suitable	2
		Commercial, Housing, Industry, Public Facilities, Infrastructure and Utility	Not Suitable	1
4.	Distance from Settlement Area	0m – 200m	Most Suitable	4
		200m – 400m	Suitable	3
		400m – 600m	Less Suitable	2
		>600m	Not Suitable	1
5.	Proximity to Road Accessibility	0m – 50m	Most Suitable	4
		50m – 200m	Suitable	3
		200m – 400m	Less Suitable	2
		>400m	Not Suitable	1
6.	Proximity to Water Access	0 – 150m	Most Suitable	4
		150m – 450m	Suitable	3
		450m – 600m	Less Suitable	2
		>600m	Not Suitable	1

Pairwise Comparison Matrix and Normalize Matrix

The pairwise comparison matrix was utilised to assess and compare each criterion and establish their relative significance (Kou, G., Ergu, D., Lin, C., & Chen, Y., 2016). The tool empowers experts to rank the six (6) criteria, such as topography (elevation and slope), land-use factors, settlement area, road accessibility, and water access, and subsequently assign weightages to them based on their level of importance. A nine-point weighting scale ranging from 1 (least important criterion) to 9 (most important criterion) was employed to determine their relative importance (Table 2).

Table 2: Pairwise comparison matrix rating scale that has been ranked by the expertise.

Criteria	Water Access	Road Accessibility	Settlement Area	Landuse	Elevation	Slope
Water Access	1.000	**3.000**	**5.000**	**7.000**	**9.000**	**9.000**
Road Accessibility	0.333	1.000	**5.000**	**7.000**	**7.000**	**7.000**
Settlement Area	0.200	0.200	1.000	**5.000**	**5.000**	**5.000**
Landuse	0.143	0.143	0.200	1.000	**3.000**	**3.000**
Elevation	0.111	0.143	0.200	0.333	1.000	**1.000**
Slope	0.111	0.143	0.200	0.333	1.000	1.000
Total	**1.898**	**4.629**	**11.600**	**20.666**	**26.000**	**26.000**

Following the pairwise comparison, the matrix plays a pivotal role in determining the weightage assigned to each criterion (Table 3). The resulting weightage is of utmost importance for conducting spatial analysis as it facilitates the examination of the criteria for site selection.

Table 3: Calculation of normalized matrix

Criteria	Slope	Elevation	Land use	Settlement Area	Road Accessibility	Water Access	Total NM
1	0.346	0.346	0.339	0.431	0.648	0.527	**2.637**
2	0.269	0.269	0.339	0.431	0.216	0.175	**1.700**
3	0.192	0.192	0.242	0.086	0.043	0.105	**0.861**
4	0.115	0.115	0.048	0.017	0.031	0.075	**0.403**
5	0.038	0.038	0.016	0.017	0.031	0.058	**0.200**
6	0.038	0.038	0.016	0.017	0.031	0.058	**0.200**
Total	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**6.000**

RESULT AND DISCUSSION

Spatial Analysis for Evaluating Land Suitability of Community Gardens

Subsequently, the six (6) criteria were incorporated into multiple layers of geographic data in preparation for spatial analysis using GIS. The application of spatial analysis in GIS-based MCDM is a powerful framework for examining spatial relationships, making predictions, and supporting decision-making (Yang, Fang, and Lai, 2017).

Topography (Slope)

Based on the analysis, it can be inferred that the most suitable area for the community garden is characterised by slopes below 15º. This particular area encompasses a total of 28,779.70 hectares, accounting for approximately 94.95% of the overall suitable land area (Figure 1).

Topography (Elevation)

Elevation plays a crucial role in determining the suitability of land for a community garden as it directly affects the availability of sunlight, water, and other essential plant-growing resources. Land that is characterised by an elevation below 150 metres is classified as "Most Suitable" for a community garden due to its proximity to water sources and comparatively, flat terrain or lower elevations are typically preferred for community gardens. This "Most Suitable" land covers 99.60% of the total analysed area, which amounts to 30,188.41 hectares. Additionally, land with an elevation ranging from 150 metres to 300 metres is deemed "Suitable" for a community garden, representing 0.40% of the total area or 122.31 hectares (Figure 2).

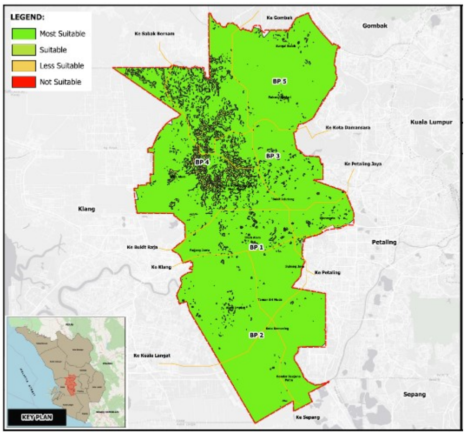


Figure 1: Slope

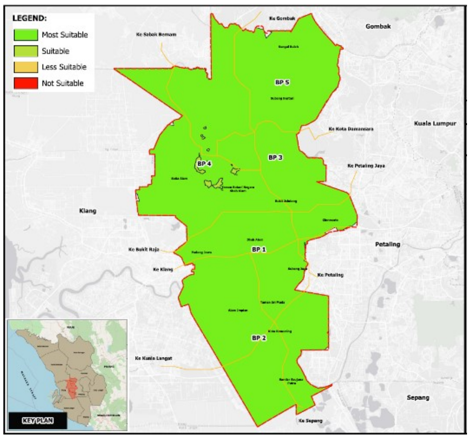


Figure 2: Elevation

Land Use

Based on the data analysis, the "Vacant land" category is identified as the most suitable, covering 15.40% of the total analysed area, which is equivalent to 4,669.26 hectares. On the other hand, land classified as "Commercial, Housing, Industry, Public Facilities, Infrastructure, and Utility" is deemed not suitable for a community garden, occupying 77.47% of the total area, which is equal to 23,482.87 hectares. The analysis encompasses a total area of 30,310.72 hectares (Figure 3).

Settlement Area

The proximity to housing is used to determine the distance from the settlement area. The analysis reveals that areas situated within 0-200 metres from housing are classified as "Most Suitable" for settlement, encompassing 56.04% of the total analysed area, equivalent to 16,985.22 hectares. Areas located more than

600 metres from housing are considered "Not Suitable" for settlement and cover 17.01% of the total area, with a total of 5,155.80 hectares (Figure 4).

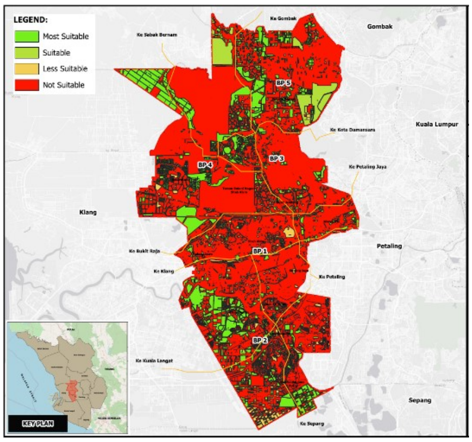


Figure 3: Land Use

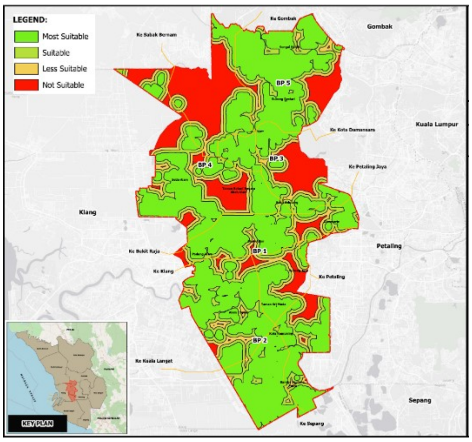


Figure 4: Settlement Area

Road Accessibility
The evaluation of proximity to road accessibility is conducted by measuring the distance to the nearest road. According to the data analysis, areas situated within 0-50 metres from a road are classified as “Most Suitable” for development, encompassing 61.52% of the total analysed area, equivalent to 18,617.53 hectares. “Less Suitable” for development, accounting for 6.46% of the total area, or 1,958.25 hectares. Lastly, areas located more than 400 metres from a road are deemed “Not Suitable” for development, covering 7.03% of the total area, with a total of 2,130.38 hectares (Figure 5).

Proximity To Water Access
The evaluation of proximity to water access involves measuring the distance to the nearest natural water body, such as a river, due to data limitations regarding water mains, waterlines, and water sources near adjacent houses. Based on the data analysis, areas situated within 0-150 metres from a water source are classified as “Most Suitable” for development, encompassing 12.91% of the total analysed area, equivalent to 3,914.47 hectares. Conversely, areas located more than 600 metres from a water source are categorised as “Not Suitable” for development, covering 61.91% of the total area, with a total of 18,763.97 hectares (Figure 6).

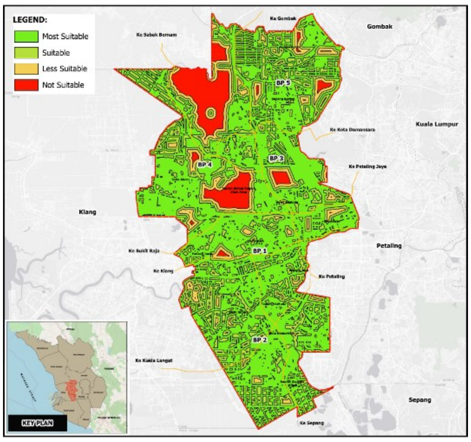


Figure 5: Road Accessibility

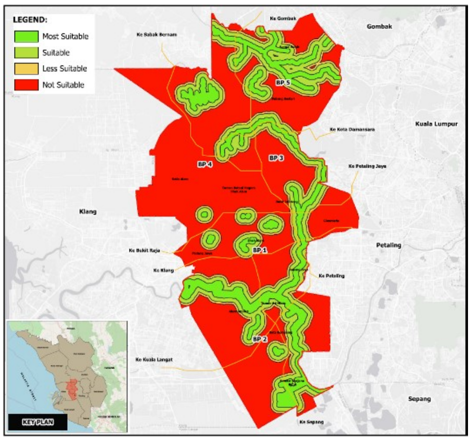


Figure 6: Proximity to Water Access

Urban Community Garden Suitability Map

The AHP analyses were utilised to calculate the weights of selected criteria, and the scores of subcriteria were assigned to map the suitability of land for an urban community garden. The land suitability for urban gardening was categorised into four classes: highly suitable, moderately suitable, marginally suitable, and not suitable. About 0.56% land of the reviewed area was classified as “Highly suitable” for urban gardening. The lands classified into this class have gentle to moderate slopes and are closed to water access and retention. However, approximately 60.88% of the area was classified as being lower or marginally suitable for urban and community gardening. An additional 13.50% of the area is categorised as not suitable for a community garden (Figure 7).

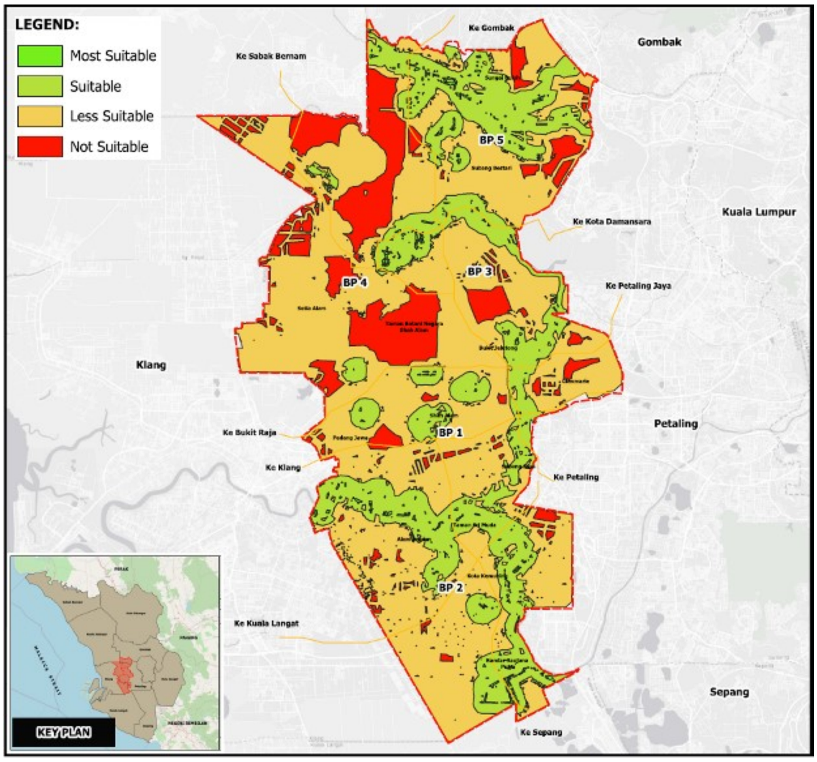


Figure 7: Urban Community Garden
Suitability Map

The study was conducted in the Petaling District in Shah Alam which is known to locate highly urbanised areas in the Selangor State. The land in this area is scarce and characterised by medium to dense development, featuring a variety of land uses. Due to these factors, the land is less conducive to urban community gardening activities, particularly in the city centre. The types of land uses present can significantly influence the suitability of an area for an urban garden. For instance, vacant lots, whether privately or publicly owned, offer excellent potential for establishing community gardens. These underutilised spaces can be transformed into thriving urban community gardens.

CONCLUSION

The study utilised a combination of AHP, descriptive analysis, and spatial analysis techniques to assess the suitability of land for an urban community garden and generate a site suitability map. As indicated, only a small percentage of the total area can be categorised as either very suitable or acceptable for a community garden. The vast majority of the land, on the other hand, falls into the categories of either less suitable or not suitable for a community garden. This information holds valuable insights for decision-makers tasked with identifying an appropriate site for a community garden.

By considering the criteria and attributes of land slope, elevation, land use, proximity to settlements, road accessibility, and water access in land suitability analysis, the selection of locations for the development and establishment of community gardens can be carried out more easily and systematically. In addition, this data can serve as a basis for future research and analysis to identify potential enhancement areas and evaluate the viability of alternative sites.

REFERENCES

Dehe, B., & Bamford, D. (2015). Development, test and comparison of two Multiple Criteria Decision Analysis (MCDA) models: A case of healthcare infrastructure location. *Expert Systems with Applications, 42*(19), 6717–6727. https://doi.org/10.1016/j.eswa.2015.04.059

Delshad, A. B. (2022). Community gardens:An investment in social cohesion, public health, economic sustainability, and the urban environment. Urban Forestry &Amp; Urban Greening, 70, 127549. https://doi.org/10.1016/j.ufug.2022.127549

DeMuro, K. (2021, April 30). The Many Benefits of Community Gardens. Greenleaf Communities. https://greenleafcommunities.org/the-many-benefitsof-community-gardens/

FAO, IFAD, UNICEF, WFP and WHO. 2022. The State of Food Security and Nutrition in the World 2022. Repurposing food and agricultural policies to make healthy diets more affordable. Rome, FAO. https://doi.org/10.4060/cc0639en

Ishak, N., Abdullah, R., Rosli, N. S. M., Majid, H., Halim, N. S. A. A., & Ariffin, F. (2022). Challenges of Urban Garden Initiatives for Food Security in Kuala Lumpur, Malaysia. *Quaestiones Geographicae, 41*(4), 57-72.

Kou, G., Ergu, D., Lin, C., & Chen, Y. (2016). Pairwise comparison matrix in multiple criteria decision making. *Technological and economic development of economy, 22*(5), 738-765.

Mccormick, K. (2020). Cities, nature and innovation: new directions. Lund: Lund University.

Ozsahin, E., & Ozdes, M. (2022). Agricultural land suitability assessment for agricultural productivity based on GIS modelling and multi-criteria decision analysis: the case of Tekirdağ province. *Environmental Monitoring and Assessment, 194*(1), 41

Pogarčić, I., Frančić, M., & Davidović, V. (2008, October). Application of AHP method in traffic planning. In *16th International Symposium on Electronics in traffic planning*.

Saaty, T. L. 1980. The analytic hierarchy process. McGraw-Hill, New York.

Tajuddin, Z., Sum, S. M., Zainol, R. M., & Jusoh, H. (2019). Penentu sosial penglibatan komuniti dalam projek kebun komuniti bandar: social determinants of community involvement in urban community garden projects. *Sarjana, 34*(1), 56-68.

Vaidya, O. S., & Kumar, S. (2006). Analytic hierarchy process: An overview of applications. *European Journal of operational research, 169*(1), 1-29.
Yang, M., Fang, L., & Lai, C. (2017). The evaluation and selection of ecoagriculture tourism site in China: An application of AHP method. *Tourism Management*, 59, 192-203.

Received: 24th July 2023. Accepted: 15th August 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 414 – 431

EXPLORING THE RELATIONSHIP BETWEEN THE PERCEIVED IMPORTANCE OF HEALTHY CITY INDICATORS AND SATISFACTION LEVELS TOWARDS THE LOCAL GOVERNMENT IN SHAPING A HEALTHY CITY

Noor Hashimah Hashim Lim[1]*, Liyana Hasnan[2], Nurdiyana Zainal Abidin[3], Md. Shahariar Chowdhury[4], Nurul Azlia Shazreen Abdul Jalil[5], Linda Shafarina Hassan[6]

[1,5]*Dept. of Urban and Regional Planning, Faculty of Built Environment,*
UNIVERSITI MALAYA
[2,3,6]*Dept. of Architecture, Faculty of Built Environment,*
UNIVERSITI MALAYA
[4]*Dept. of Sustainable Energy, Faculty of Environmental Management,*
PRINCE OF SONGKLA UNIVERSITY

Abstract

This study explores the correlation between the perceived importance of healthy city indicators and the satisfaction level towards the effectiveness of the government in creating a healthy city environment. Nineteen distinct healthy city indicators, categorised within 5 dimensions, were tested for their significance in relation to satisfaction levels towards the effectiveness of the local authority. The cross-sectional data collected from face-to-face questionnaire survey was analysed using Goodman and Kruskal's gamma, while controlling for socio-demographic variables (n=121). Significant indicators include; (i) improving accessibility to public spaces (β= .528, p= .004), recreational and commercial areas (β= .506, p= .001); (ii) increasing the availability of public transport (β= .398, p= .026) complemented by proper infrastructures and facilities (β= .305, p= .014), (iii) providing more variety of green spaces (β= .529, p= .004), and improving the continuity of green networks (β= .399, p= .015); (iv) introducing measures to improve the quality of housing, focusing on increasing occupants' comfortability and healthy living (β= .474, p= .005); (v) facilitating better accessibility to business and commercial areas (β= .598, p= .000); (vi) improving street connectivity and increasing the number of intersections (β= .418, p= .002). Although this study only found a meaningful connection between the perceived importance of indicators and satisfaction levels towards the government without a comparative analysis against the current city condition, this does not negate the crucial role of subjective perceptions in the government's efforts to manage public expectations. Studies of this nature provide opportunities for further exploration, particularly in involving public participation in the planning processes.

***Keywords*:** Healthy city, public participation, public perception, Urban governance, Local government

[1] Senior Lecturer at Universiti Malaya. Email: shimalim@um.edu.my

INTRODUCTION

Numerous studies have shown strong indications that an individual's health is influenced by factors beyond the personal sphere (Meng, et al., 2006), extending to a wider context which includes neighbourhoods, communities, and even national-level externalities. According to the World Health Organisation (2016), efforts to cultivate a healthy community necessitates attention not only to the health sector but also to investments in planning across social, physical, and environmental realms. Hence, the responsibility for achieving and sustaining a state of health transcends individual efforts, resting also upon the shoulders of policymakers and the government (Leh, et al., 2011).

On this note, many governments have started to prioritise and incorporate the element of health into their long-term urban planning strategies. This global trend is evident in the deliberate integration of the features of ideal healthy cities into the respective master plans of concerned governments (Harpham, Burton & Blue, 2001; Barton & Grant, 2013). Such efforts are particularly crucial for countries undergoing rapid urbanisation, such as those in Southeast Asia. Given the dynamic shifts in urban morphology, it becomes paramount for decision-makers in these swiftly evolving cities to remain cognisant of developments and their implications on the well-being of its inhabitants. This vigilance serves to mitigate uncertainties within the society in question. However, there remains room for refinement in evaluating the efficacy of these features of healthy city features and in effectively monitoring the progress of these plans (De Leeuw, 2009), especially for Southeast Asian countries (De Leeuw & Simos, 2017).

While most research focuses on assessing the positive impact of a city's urban environment on the health of its inhabitants (Paquet, Cargo, Kestens & Daniel, 2010; De Leeuw, et al., 2015), there is a relative lack of studies dedicated to soliciting feedback from the target population. Gathering input from the public not only reinforces but also encourages active public participation in the planning and policy-making processes. Urban planning that values and incorporates public perspectives can substantially contribute to the creation of a more human-centric living environment. In line with the concept of public participation through advocacy planning forwarded by Davidoff in the 1960s, numerous contemporary studies have established a correlation between the satisfaction levels of the target population and the likelihood of success in government initiatives (Andrews, 2018; Zyed et al., 2021).

Building on this premise, Bryson (2018) advocates for strategic plans as a means to increase public trust and garner support, thereby ensuring the quality and effectiveness of government initiatives. This is further supported by McLean & Roblyer (2017), which asserts that public endorsement shapes policy effectiveness through individual subjective evaluations. The author contends that the higher the perceived effectiveness, the greater the support the government will receive.

Consequently, the first step in managing public expectations lies in an understanding of the perspectives and sentiments of the intended population. Integral to shaping an environment conducive to healthy living habits is the active integration of perspectives from the intended population by decision-makers. Friedman (1987) and Forester (1999), as cited in Corburn (2009), argued that public participation in the planning process and urban governance serves as a mediator of disagreements, thereby facilitating greater support for and success of the proposed plan. Consulting with the intended population prior to significant decision-making, whether through formal or informal methods, as advocated by Forester (1999) and reinforced by Corburn (2009), promotes consensual decision-making among multiple stakeholders, ultimately leading to more rationalised outcomes (Hashim, 2021).

Furthermore, in the absence of important questions such as "how receptive are the inhabitants towards the government's initiatives in creating a healthy city?", "do they think that the plans made by the government are important in achieving the ultimate goals?" as well as "how satisfied are they with the government's initiatives?", critical insights from the intended population are overlooked. Without this essential understanding, the government's ability to formulate a rational and equitable plan is compromised. Recognising this evident gap, it becomes imperative to gather such data, with the ultimate goal of providing the government with a more nuanced comprehension of the subject at hand.

The public's perception of the importance of initiatives plays a crucial role in their subjective evaluation of the government's effectiveness in planning towards a healthy city. As such, this study aims to explore the correlation between the perceived importance of healthy city indicators and their satisfaction levels towards the government's effectiveness in creating a healthy city environment. In addition, this study also offers a unique opportunity to understand what constitutes a 'healthy city' as perceived by the public. Building on the insights of De Leeuw (2009), soliciting public opinions enables the government to create a healthy city with a more harmonised alignment between public expectations and the governmental aspirations. The feedback also helps the government to assess the extent of support or potential lack of participation in its initiatives.

LITERATURE REVIEW

A systematic literature review conducted by Rothenberg, et al. (2015) revealed that urban health indicators encompass a broad spectrum, including health status and healthcare infrastructure, environmental factors, geographical attributes, economic variables and socio-demographic characteristics. Diverse experts from various fields have also contributed a myriad of healthy city indicators, spanning disciplines such as transportation planning (Mueller, et al., 2021), information systems (Van Oers & Reelick, 1992), public policy (Li, et al., 2020) and occupational health (Boarin, Besen & Haarhoff, 2018), among others. The European Healthy Cities Network of the World Health Organisation also introduced a 53-item healthy city indicator set, later refined to 32 items by Webster & Sanderson (2013). Drawing on extensive literature, this review identifies five dimensions that have consistently emerged as significant in shaping a conducive environment for healthy living in previous studies.

Area density. Northridge & Sclar (2003), supported by Giles-Corti, Ryan & Foster (2012) stated that although continuous growth in population and density is an unavoidable consequence of rapid urbanisation, the creation of healthy living conditions remains achievable through insights from relevant field experts. The authors underscore the significance of vigilant monitoring and assessment of population and density patterns, deeming them crucial determinants of overall population health. As urban populations surge, the increase in accessibility to commercial areas assumes paramount importance in fostering a healthy living environment (Frank, et al., 2005; Powell, et al., 2007). In the recent global COVID-19 pandemic outbreak, studies have found that the population density is correlated to the severity of COVID-19 spread (Roy & Gosh, 2020; Han, et al., 2021; Teh, et al, 2022).

Mobility and transport. A systematic literature review and meta-analysis conducted by Jia et al. (2021) examined the relationship between street connectivity and physical activity among obese children, revealing a clear positive association between these variables. This correlation is also evident in the adult population (Frank, et al., 2005). Additionally, the availability of high-quality active transport infrastructure, encompassing facilities for cycling and walking, demonstrated a beneficial impact on healthy living habits, particularly in encouraging increased levels of physical activity (Van Dyck, et al., 2011; Nijkamp & Mobach, 2020). A healthier living environment can also be fortified by well-developed public transportation infrastructures (Lowe, Boulange & Giles-Corti, 2014), particularly benefiting individuals with limited mobility options (Grant, 2018).

Mixed-use and proximity. Healthy behaviours can be stimulated via the strategic provision of public facilities, recreational spaces and commercial areas in close proximity to both workplaces and residential areas (Gehl, 2011; Pozoukidou & Chatziyiannaki, 2021). Proximity facilitates easier access for individuals of varying physical abilities, promoting increased mobility and physical activity among residents. This closeness of destinations also creates diverse land-use mix encouraging not only more physical activity, but also increasing the likelihood of readily available healthy food options near workplaces and residences (Sallis & Glanz, 2009; Lowe, Boulange & Giles-Corti, 2014). Consequently, this proximity leads to an improved quality of dietary choices (Majid, Lim, Zaman & Ruslik, 2021).

Environment and urban landscape. Numerous studies have provided evidence that improving green and blue coverage yields substantial benefits for an individual's health, regardless of mental, physical or overall well-being (Pouso, et al., 2021; Markevych, et al., 2017). The equitable distribution of these qualities across locales and population, together with a robust network of green spaces (Moseley, Marzano, Chetcuti & Watts, 2013; Nieuwenhuijsen, 2021), provides opportunities for social interaction and communion with nature, thereby encouraging increased physical activity and active movement.

Housing quality and energy efficiency. Good housing quality serves as a form of preventative medicine, effectively mitigating general health risks, enhancing climate resilience, and, in some cases, minimising carbon footprint. It is highly encouraged for governments to provide houses with better energy efficiency features, a proposition suggested by Visscher, Meijer, Majcen & Itard (2016), who assert that well-performing buildings can significantly influence occupational behaviours, consequently contributing to improved health status. Furthermore, houses with better quality have demonstrated positive effects on both net mortality and morbidity (Hamilton, et al., 2015), affording occupants better indoor air quality and temperature regulation, among other benefits.

MATERIALS AND METHODS

Study design

This study intends to explore the correlation between the perceived importance of healthy city indicators and their satisfaction levels concerning the effectiveness of the government in cultivating a healthy city environment. The selected study site is the Federal Territory of Kuala Lumpur, serving as the capital city of Malaysia. This area falls under the administration of the Kuala Lumpur City Hall (DBKL), encompassing a total land area of 243 square kilometres. The city's strategic vision, outlined in the Kuala Lumpur Structure Plan 2040, aspires to be a healthy and vibrant city by 2040. Therefore, in this study, DBKL, as the local governing body, is regarded as the representative entity signifying "the government".

As of 2022, the population of Kuala Lumpur stands at 1.9 million (Department of Statistics Malaysia, 2022). From this demographic, respondents were selected based on specific eligibility criteria; i) aged 18-years or older; ii) able-bodied Malaysians with a residency of more than five years within the administrative area of DBKL; and iii) either a house owner or renter. Employing a simple random sampling technique, respondents were further stratified by gender. Although the precise size of the targeted population based on the eligibility criteria is unknown, it is presumed to be substantial, likely exceeding

100,000 individuals. Hence, employing Yamane's (1967) sampling size calculation, and considering a 90% confidence level for populations exceeding 100,000, the minimum sample size required for this study is set at a minimum of 100 respondents.

Data collection took place over a three-month period, spanning from July 2022 to September 2022, via face-to-face questionnaire surveys. The questionnaire consisted of 3 sections: the first solicited demographic information from respondents (3 questions), the second focused on assessing the perceived importance of healthy city indicators (19 questions), and the third evaluated satisfaction levels regarding the government's effectiveness in creating a healthy city environment (1 question). All collected data were recorded and subsequently analysed using the IBM Statistical Package for Social Sciences (SPSS) version 22.0.

Independent variables: Healthy city indicators

Nineteen indicators categorised under five healthy city dimensions were included in the study (refer Table 2). The respondents were asked to rate their perceived importance of those indicators in shaping a healthy city through a 4-point Likert scale (1: Extremely not important, 2: Not important, 3: Important, and 4: Extremely important).

1. Area density (2 items): Increase in the number of populations, residential units, business activities and commercial spaces in an area.
2. Mobility and transport (6 items): Increase in street connectivity and number of intersections. Improve accessibility to public spaces, cycling connectivity, pedestrian networks and infrastructures, availability and efficiency of public transport services as well as reducing the speed of, and volume of traffic.
3. Mixed-use and proximity (4 items): Provide public facilities, recreational and commercial areas that are in close proximity to workplace and residential areas. Integrate public facilities and institutions through mixed development as well as improve the food environment.
4. Environment and urban landscape (5 items): Improve and increase green coverage, blue spaces as well as green networks.
5. Housing Quality and Energy Efficiency (2 items): Measures to improve the quality and energy efficiency of housing.

Dependent variable: Satisfaction Level Towards the Government

As previously mentioned, the Kuala Lumpur City Hall (DBKL), as the local governing body, serves as the representative embodiment of "the government" in this study. As such, respondents were asked about their overall satisfaction level towards the current efforts undertaken by their local authority to integrate healthy city features into their place of residence. They were to provide a response using a 4-point Likert scale, ranging from 1: Extremely not satisfied, 2: Not satisfied, 3: Satisfied to 4: Extremely satisfied. This deliberate reduction in the scale was implemented to force subjects to formulate distinct opinions and offer specific responses, steering clear of the potentially ambivalent "neutral" middle category.

Controlled variables: Socio-demography

The socio-demographic details collected from the respondents were their gender (1: Male, 2: Female), age (1: 18 to 29 years old, 2: 30 to 49 years old, 3: 50 to 69 years old, and 4: 70 years old and above), ethnicity (1: Malay, 2: Chinese, 3: Indian, and 4: Others) and education level (1: Without tertiary education, and 2: With tertiary education). The categorisation for monthly household income follows the three income level classifications based on the Household Income and Basic Amenities survey 2019 by the Department of Statistics Malaysia (DOSM) (1: less than RM4,850, 2: RM4,851 – RM10,960, and 3: more than RM10,961).

Content validity

Given Malaysia's diverse cultural landscape, a content validity was conducted to ensure cross-cultural appropriateness in the language and terminology employed in the questionnaire. The survey questions underwent initial scrutiny and deliberation by two experts in the fields of urban and regional planning to assess its suitability for use among Malaysian residents. Both experts were contacted beforehand and apprised of the study's objectives. The experts were tasked with providing open-ended feedback on the instrument, evaluating its importance, language used and ease of comprehension. The feedback provided was collated, and both experts concurred that the questionnaire is indeed suitable for use within the Malaysian context.

Subsequently, linguistic equivalence was ensured by adhering to the instrument translation process as introduced by the World Health Organisation. First, a forward translation was conducted by a Malay-English bilingual translator well-versed in the survey's concept and terminology. This was then reviewed by the same experts mentioned earlier to address any deficiencies in word choice and suggest alternative expressions. Following this, a back-translation was carried out by an independent translator with no prior knowledge of the survey's objectives. As a result, a bilingual questionnaire offering respondents the choice between English and Malay languages was produced.

Data Analysis

Data Screening

All statistical analyses were conducted using the Statistical Package for Social Sciences version 19.0. Data screening revealed no instances of missing data among the respondents (n=121). During the assessment of unengaged responses, it was observed that all items exhibited a standard deviation value of higher than 0.3, indicating a commendable level of respondent engagement. Outliers were checked for all items using the Mahalanobis Distance Stem-and-Leaf Plot. Although eight cases were initially flagged as outliers, none of the cases could be definitively classified as atypical. Hence, all 121 cases were retained for subsequent analysis.

Monotonic Relationship/ Linearity

Evidence of monotonic relationship between the indicators of the five healthy city dimensions and the satisfaction level towards the local authority was asserted by using the Scatterplot.

Correlation

As the variables were measured on an ordinal scale and and demonstrated a monotonic relationship, the study employed a non-parametric measure, Goodman and Kruskal's gamma, to examine the correlation between the perceived importance of healthy city indicators and their satisfaction levels towards the government's effectiveness in establishing a healthy city environment. This analysis controlled for socio-demographic factors. The significance threshold was set at $p < .05$ with a 95% confidence interval level, and an acceptable strength of relationship was defined as at least a moderate beta-value of $\beta > .04$.

RESULTS

Socio-demographic characteristics and satisfaction level towards the effectiveness of the government in creating a healthy city environment

A total of 121 eligible respondents participated in the questionnaire survey (**Table 1**). Among them, half fell within the 18 to 29 years age group (50%), with a slight majority being male (54%) and identifying as Malay ethnicity (56%). A significant portion held tertiary education qualifications (73%), and most reported a monthly household income of less than RM4,850 (65%). In terms of satisfaction levels, the majority expressed dissatisfaction, with 55% not satisfied and 7% extremely unsatisfied with the current efforts of the local authority in creating a healthy living environment. This totalled to 62% of respondents registering dissatisfaction. However, the remaining respondents (34%) reported satisfaction and 4% expressed extreme satisfaction with the ongoing efforts of the local authority, denoting a combined positive response rate of 38%.

Perceived importance of healthy city indicators and their satisfaction levels towards the effectiveness of the government in creating a healthy city environment

The correlation between the perceived importance of healthy city indicators and satisfaction levels towards the government's effectiveness in creating a healthy city environment was assessed using Goodman and Kruskal's gamma, with control for socio-demographic variables (**Table 2**). Both indicators within the area density dimension exhibited significant correlations with satisfaction levels regarding government effectiveness. Most respondents perceived that the increase in population and residential density (β= .644, p= .000) of an area was not deemed important (36%) in creating a healthy living environment. However, a significant proportion regarded increasing accessible business and commercial density (β= .598, p= .000) as an important determinant (46%).

Within the dimension of mobility and transport, only three indicators demonstrated significance. Half of the respondents felt that the increase in street connectivity and the number of intersections in an area (β= .418, p= .002) is an important (50%) contributor to a healthy living environment. A large majority considered it extremely important (75%) for the government to improve accessibility to public spaces (β= .528, p= .004). Similarly, a substantial proportion found increasing the availability of public transport (β= .398, p= .026) was deemed extremely important (72%).

Table 1: Socio-demographic characteristics and satisfaction level towards local authority of respondents (n= 121) and proportion of distribution by gender

	Overall, *100%*	Proportion Distribution, *100%* Gender	
		Male (54%)	Female (46%)
Age, *%*			
18 - 29 years old	50	64	34
30 - 49 years old	22	21	23
50 - 69 years old	22	8	39
≥70 years old	6	7	4
Race, *%*			
Malay	56	58	54
Chinese	35	34	38
Indian	7	5	9
Others	2	3	-
Education level, *%*			
Without tertiary education	27	29	25
With tertiary education	73	71	75
Monthly household income, *%*			
≤ RM4,850	65	65	66
RM4,851 – RM10,960	27	32	21
≥ RM10,961	8	3	13

	Overall, *100%*	Proportion Distribution, *100%* Gender	
Satisfaction level towards local authority, *%*			
Extremely not satisfied	7	5	11
Not satisfied	55	48	12
Satisfied	34	43	70
Extremely satisfied	4	5	7

While a majority of respondents expressed a belief in the importance of increasing cyclability and cycling infrastructure (61%, β= .024, p= .875), enhancing walkability and pedestrian infrastructure (60%, β= .282, p= .088) and reducing traffic speed and/or volume (60%, β= -.016, p= .917) for creating a healthy living environment, none of these indicators were found to have significance influence on satisfaction levels towards the government.

Two significant indicators within the dimension of mixed-use and proximity were found to influence respondents' satisfaction levels towards the government. A significant majority of respondents emphasised the extreme importance of the local authority providing public facilities, recreational and commercial areas in close proximity to residential areas (60%, β= .506, p= .001), as well as providing public transport infrastructures and facilities that are connected to their workplaces and residences (64%, β= .305, p= .014). While the integration of public facilities and institutions with commercial spaces and residences was perceived as extremely important (52%, β= .227, p= .162), and improving the food environment was deemed important (44%, β= .113, p= .434), both were not found to be significant factors affecting satisfaction levels towards the government's efforts in creating a healthy city.

While all five indicators within the environment and urban landscape dimension were deemed extremely important by the respondents for creating a healthy city, only two indicators were found to be significantly associated with satisfaction levels towards the government, i.e., most respondents emphasised the significance of providing a diverse range of green areas (68%, β= .529, p= .004) and improving the continuity of green networks within their living environment (61%, β= .399, p= .015) was extremely important in shaping a healthier city environment. On the contrary, improving and increasing green coverage and visibility (70%, β= .242, p= .190), improving and increasing the proximity and visibility of blue spaces (63%, β= -.180, p= .251), as well as improving the urban landscape and amenities in public open spaces (53%, β= -.077, p= .634) were not deemed significant factors influencing satisfaction levels.

In the dimension of housing quality and efficiency, the majority of respondents emphasised that measures to improve quality of housing for comfortability and healthy living (69%, β= .474, p= .005), as well as measures to improve the energy efficiency of housing (54%, β= .028, p= .865) were extremely important features of a healthy city. However, only the former was found to be significantly correlated with respondents' satisfaction levels towards the government, while the latter did not exhibit a significant correlation.

DISCUSSION

The core premise of this study asserts that an individual's perception of the importance of a healthy city indicator, when aligned with its presence in their current place of residence, influences their satisfaction level towards the government's efforts to shaping a healthy city, and vice versa. Through this understanding, the correlation between the public's perceived importance of healthy city indicators and their satisfaction levels towards the government's effectiveness in creating a healthy city environment was explored, focussing on the context of a local authority in the capital city of Malaysia. Nineteen indicators categorised under five dimensions were assessed; area density (2 items), mobility and transport (6 items), mixed use and proximity (4 items), environment and urban landscape (5 items), and housing quality and energy efficiency (2 items). Among these 19 healthy city indicators, 10 were identified as significant factors affecting satisfaction levels towards the local authority's efforts in shaping a healthy city.

There are seven indicators marked as 'extremely important' that significantly influence satisfaction levels towards the local authority's efforts in shaping a healthy city. It is highly recommended for the local authority to prioritise these indicators in future healthy city planning, as doing so will likely increase public satisfaction with the provided services. These essential factors include (i) improving accessibility to public spaces, especially public facilities, recreational and commercial areas, from residential areas; (ii) increasing the availability of public transport , complemented by adequate infrastructure and facilities that are connected to workplaces and residential areas; (iii) providing more variety of green spaces and improving the continuity of green networks within an area; and (iv) implementing measures to improve the quality of housing, focusing on increasing occupant comfortability and healthy living.

Two indicators deemed as 'important' contributors to a healthy city include (v) improved accessibility to business and commercial areas, as well as planning for (vi) better street connectivity and increasing the number of intersections. This is in tandem with a myriad of studies emphasising the correlation between healthy behaviours to close proximity and convenient access to commercial activities from residential areas, as well as the availability of sufficient parking lots in those commercial areas. Given the statistical significance of these two indicators in influencing satisfaction levels towards healthy city planning efforts, it is recommended for the local authority to give due consideration to these aspects in the planning for future healthy cities.

The respondents viewed increasing population and residential density as less important indicators of a healthy city. This perspective is entirely understandable from a layperson's point of view, as discussions surrounding a healthy living environment typically do not immediately evoke thoughts of population nor density. Most do not realise that residing in the capital city of a developing country inherently entails a trajectory of rapid urbanisation, resulting in a growing pattern of population and residential density. Consequently, city residents will have to coexist and share residences, commercial areas, public facilities and amenities with a larger population; potentially affecting public health. Additionally, in light of the recent Covid-19 pandemic, there has been a heightened emphasis on avoiding overcrowded areas and adhering to social distancing measures as crucial elements in maintaining public health.

Table 2: Distribution of the respondents' perceived importance of healthy city indicators on a 4-point Likert scale (n= 121)

Healthy city indicators	Perceived importance of healthy city indicators				Correlation to satisfaction level towards local authority
	Extremely not important, %	Not important, %	Important, %	Extremely important, %	β-value (*p*-value)
Dimension 1: Area Density, %					
Increase in population and residential density	15	36	31	18	.644** (.000)
Increase accessible business and commercial density	14	19	46	21	.598** (.000)
Dimension 2: Mobility and Transport, %					
Increase street connectivity and number of intersections	10	11	50	29	.418** (.002)
Improve accessibility to public spaces	5	-	20	75	.528** (.004)
Increase cyclability and cycling	-	7	32	61	.024 (.875)
infrastructure	5	-	35	60	.282 (.088)
Increase walkability and pedestrian					
infrastructure	5	-	23	72	.398* (.026)
Increase availability of public transport	2	4	34	60	-.016 (.917)
Reduce the speed and/or volume of traffic					
Dimension 3: Mixed-use and Proximity, %					
Provide public facilities, recreational and commercial areas close to residential area	3	-	36	60	.506** (.001)
Provide public transport infrastructures and facilities that are connected to workplace and residence	5	-	31	64	.305** (.014)
	4	1	43	52	.227 (.162)

Healthy city indicators	Perceived importance of healthy city indicators				Correlation to satisfaction level towards local authority
	Extremely not important, %	Not important, %	Important, %	Extremely important, %	β-value (*p*-value)
Integrate public facilities and institutions with commercial spaces and residence	2	12	44	42	.113 (.434)
Improve food environment					
Dimension 4: Environment and Urban Landscape, %					
Improve and increase green coverage and visibility	3	1	26	70	.242 (.190)
Provide varied types of green areas	5	1	26	68	.529** (.004)
Improve and increase proximity and visibility of blue spaces	-	7	31	63	-.180 (.251)
Improve continuity of green networks	3	1	35	61	.399** (.015)
Improve the urban landscape and amenities in public open spaces	-	3	44	53	-.077 (.634)
Dimension 5: Housing Quality and Efficiency, %					
Measures to improve quality of housing for comfortability and healthy living	4	-	27	69	.474** (.005)
Measures to improve the energy efficiency of housing	5	-	41	54	.028 (.865)

$*p < 0.05$, $**p < 0.01$

Given that this indicator significantly influences satisfaction levels towards the local authority, it is recommended for the government to increase public awareness regarding the importance of acknowledging that health extends beyond individual efforts to encompass population-level health approaches. This perspective, as supported by the United Nations and penned by Wilmoth, Menozzi & Bassarsky (2022) as well as Curry (2005), approaching health from a population perspective helps a country to understand that higher population and residential density amplifies its harmful impacts on health. Consequently, addressing this issue should be prioritised not only by local authorities, but also by the federal government.

There are seven ‘extremely important’ indicators that are significant in influencing satisfaction level towards the local authority’s efforts in shaping a healthy city. From the output, it is highly recommended for the local authority to emphasize these indicators into future healthy city planning of the area in order to increase the public’s satisfaction level towards the public services. It includes (i) improving accessibility to public spaces, especially public facilities, recreational and commercial areas, from residential areas; (ii) increasing the availability of public transport supported by proper infrastructures and facilities that are connected to workplace and residential areas; (iii) providing more variety of green spaces as well as improving the continuity of green networks within an area; and (iv) introduce measures to improve the quality of housing, focusing on increasing occupant's comfortability and healthy living.

Two indicators thought to be 'important' contributors to a healthy city includes (v) a higher accessibility to business and commercial areas, as well as planning for (vi) a better street connectivity and increasing the number of intersections. This is in tandem with the results of a myriad of studies linking healthy behaviours to close proximity and having good accessibility to commercial activities from residential areas as well as having sufficient parking lots in those commercial areas. As these two indicators are statistically significant in influencing satisfaction level towards efforts in healthy city planning, it is recommended for the local authority to also pay attention to these two aspects when planning for future healthy cities.

Increasing population and residential density were thought to be an unimportant indicator of a healthy city by the respondents. This result is fully understandable from a laymen's point of view, as when talking about healthy living environment, the first thing that comes to mind is almost always not population nor density. Most do not realise that, living in the capital city of a developing country, means that rapid urbanisation will bring about a growing pattern of population and residential density. As a consequence of that, city residence will have to live and share residences, commerce, public facilities and amenities with a lot more people; thereby affecting public health. Additionally, with the advent of the recent Covid-19 pandemic, avoiding overcrowded areas and observing social distance have been encouraged as measures to maintaining public health.

Because this is a significant indicator that influences satisfaction level towards the local authority, it is recommended for the government to increase public awareness on the importance of acknowledging that health status extends beyond individual-level efforts. On a larger scale, it needs population-level health approaches as well. As supported by the United Nations, penned by Wilmoth, Menozzi & Bassarsky (2022) as well as Curry (2005), approaching health from a population perspective helps a country to understanding that higher population and residential density magnifies its harmful impacts towards health. And that this should be a priority for the local authority, right to the federal government to address.

CONCLUSION

The findings of this study illuminate how the perceived importance of specific aspects can influence satisfaction levels towards government efforts. While it is worth noting that this study establishes a meaningful connection between the perceived importance of indicators and satisfaction levels towards the government without directly comparing the dataset with the current city condition, it still underscores the pivotal role of subjective perceptions in the government's efforts in managing public expectations. Studies such as this provide valuable opportunities for further exploration in integrating public participation into the planning processes, particularly in the pursuit of shaping a healthy city.

REFERENCES

Andrews, M. (2018). Public Policy Failure: 'How Often?'and 'What is Failure, Anyway'? *CID Working Paper Series*.

Barton, H., & Grant, M. (2013). Urban planning for healthy cities: A review of the progress of the European Healthy Cities Programme. *Journal of urban health*, *90*, 129-141.

Boarin, P., Besen, P., & Haarhoff, E. (2018). Post-Occupancy Evaluation of Neighbourhoods: a review of the literature. *Building Research & Information*, 29(2), 168-174.

Bryson, J. M. (2018). *Strategic planning for public and nonprofit organizations: A guide to strengthening and sustaining organizational achievement*. John Wiley & Sons.

Corburn, J. (2009). Toward the healthy city. *Massachusetts Institute of Technology, Cambridge, Massachusetts*.

Curry, L. (2005). The Future of the Public's Health in the 21st Century. *Generations Journal*, *29*(2), 82.

De Leeuw, E. (2009). Evidence for Healthy Cities: reflections on practice, method and theory. *Health promotion international*, *24*(suppl_1), i19-i36.

De Leeuw, E., Green, G., Dyakova, M., Spanswick, L., & Palmer, N. (2015). European Healthy Cities evaluation: conceptual framework and methodology. *Health promotion international*, *30*(suppl_1), i8-i17.

De Leeuw, E., & Simos, J. (Eds.). (2017). *Healthy cities: the theory, policy, and practice of value-based urban planning*. Springer.

Department of Statistics Malaysia (2022). https://dev.dosm.gov.my/portal-main/release-content/current-population-estimates-malaysia-2022

Frank, L. D., Schmid, T. L., Sallis, J. F., Chapman, J., & Saelens, B. E. (2005). Linking objectively measured physical activity with objectively measured urban form: findings from SMARTRAQ. *American journal of preventive medicine*, *28*(2), 117-125.

Gehl, J. (2011). "Three Types of Outdoor Activities,""Life Between Buildings," and "Outdoor Activities and the Quality of Outdoor Space": from Life Between Buildings: Using Public Space (1987). In *The city reader* (pp. 586-608). Routledge.

Giles-Corti, W., Ryan, K., & Foster, S. (2012). Increasing density in Australia: maximising the health benefits and minimising the harm. *The National Heart Foundation of Australia*.

Giles-Corti, B., Moudon, A. V., Lowe, M., Adlakha, D., Cerin, E., Boeing, G., ... & Sallis, J. F. (2022). Creating healthy and sustainable cities: what gets measured, gets done. *The Lancet Global Health*, *10*(6), e782-e785.

Grant, M. (2019). Planning for healthy cities. *Integrating Human Health into Urban and Transport Planning: A Framework*, 221-250.

Hamilton, I., Milner, J., Chalabi, Z., Das, P., Jones, B., Shrubsole, C., ... & Wilkinson, P. (2015). Health effects of home energy efficiency interventions in England: a modelling study. *BMJ open*, *5*(4), e007298.

Han, Y., Yang, L., Jia, K., Li, J., Feng, S., Chen, W., Zhao, W. & Pereira, P. (2020). Spatial Distribution Characteristics of the COVID-19 in Beijing and its Relationship with Environmental Factors. *Science of The Total Environment*, 761, 144257.

Harpham, T., Burton, S., & Blue, I. (2001). Healthy city projects in developing countries: the first evaluation. *Health Promotion International*, *16*(2), 111-125.

Hashim, N.H.N. (2021). *A Framework for Sustainable Urban Regeneration (SUR) in Historical Inner Cities: The Case of KL Sentral*. Unpublished PhD Thesis, University of Malaya, Kuala Lumpur, Malaysia.

Jia, P., Zou, Y., Wu, Z., Zhang, D., Wu, T., Smith, M., & Xiao, Q. (2021). Street connectivity, physical activity, and childhood obesity: a systematic review and meta-analysis. *Obesity Reviews*, *22*, e12943.

Leh, O. L. H., Ahmad, S., Aiyub, K., & Jani, Y. M. (2011). Urban air environmental health indicators: A preliminary set for city of Kuala Lumpur. *Planning Malaysia*, 9.

Li, T., Fang, Y., Zeng, D., Shi, Z., Sharma, M., Zeng, H., & Zhao, Y. (2020). Developing an indicator system for a healthy City: Taking an urban area as a pilot. *Risk Management and Healthcare Policy*, *13*, 83.

Lowe, M., Boulange, C., & Giles-Corti, B. (2014). Urban design and health: progress to date and future challenges. *Health promotion journal of Australia*, *25*(1), 14-18.

Luo, J., Chan, E. H., Du, J., Feng, L., Jiang, P., & Xu, Y. (2022). Developing a health-spatial indicator system for a healthy city in small and midsized cities. *International Journal of Environmental Research and Public Health*, *19*(6), 3294.

Majid, M. R., Lim, N. H. H., Zaman, M., & Ruslik, N. (2021). Exploring the Link between BMI, Perceived Neighbourhood Environment and Health Behaviours in Malaysia. *Journal of Sustainability Science and Management*, *16*(7), 190-208.

Markevych, I., Schoierer, J., Hartig, T., Chudnovsky, A., Hystad, P., Dzhambov, A. M., ... & Fuertes, E. (2017). Exploring pathways linking greenspace to health: Theoretical and methodological guidance. *Environmental research*, *158*, 301-317.

McLean, E. V., & Roblyer, D. A. (2017). Public support for economic sanctions: An experimental analysis. *Foreign Policy Analysis*, *13*(1), 233-254.

Meng, L. L., Abdullah, A., Fern, T. S., Badarulzaman, N., & Hassan, A. S. (2006). How we failed to plan for habitability. *Planning Malaysia*, 4.

Moseley, D., Marzano, M., Chetcuti, J., & Watts, K. (2013). Green networks for people: Application of a functional approach to support the planning and management of greenspace. *Landscape and urban planning*, *116*, 1-12.

Mueller, N., Daher, C., Rojas-Rueda, D., Delgado, L., Vicioso, H., Gascon, M., ... & Nieuwenhuijsen, M. (2021). Integrating health indicators into urban and transport planning: A narrative literature review and participatory process. *International Journal of Hygiene and Environmental Health*, 235, 113772.

Nijkamp, J. E., & Mobach, M. P. (2020). Developing healthy cities with urban facility management. *Facilities*, *38*(11/12), 819-833.

Nieuwenhuijsen, M. J. (2021). Green infrastructure and health. *Annual Review of Public Health*, *42*, 317-328.

Northridge, M. E., & Sclar, E. (2003). A joint urban planning and public health framework: contributions to health impact assessment. *American journal of public health*, *93*(1), 118-121.

Paquet, C., Cargo, M., Kestens, Y., & Daniel, M. (2010). Reliability of an instrument for direct observation of urban neighbourhoods. *Landscape and urban planning*, *97*(3), 194-201.

Pouso, S., Borja, Á., Fleming, L. E., Gómez-Baggethun, E., White, M. P., & Uyarra, M. C. (2021). Contact with blue-green spaces during the COVID-19 pandemic lockdown beneficial for mental health. *Science of The Total Environment*, *756*, 143984.

Powell, L. M., Chaloupka, F. J., Slater, S. J., Johnston, L. D., & O'Malley, P. M. (2007). The availability of local-area commercial physical activity–related facilities and physical activity among adolescents. *American journal of preventive medicine*, *33*(4), S292-S300.

Pozoukidou, G., & Chatziyiannaki, Z. (2021). 15-Minute City: Decomposing the new urban planning eutopia. *Sustainability*, *13*(2), 928.

Rothenberg, R., Stauber, C., Weaver, S., Dai, D., Prasad, A., & Kano, M. (2015). Urban health indicators and indices—current status. *BMC Public Health*, 15, 1-14.

Roy, S. & Gosh, P. (2020). Factors Affecting COVID-19 Infected and Death Rates Inform Lockdown-related Policymaking. *PLOS ONE*, 15(10), e0241165. https://doi.org/10.1371/journal.pone.0241165

Sallis, J. F., & Glanz, K. (2009). Physical activity and food environments: solutions to the obesity epidemic. *The Milbank Quarterly*, *87*(1), 123-154.

Teh, B.T., Gabriel Ling, H.T., Hashim Lim, N.H., & Leng P.C. (2022). Factors Determining COVID-19 Severity in Malaysia: From Social, Economic and Environment Perspectives. *Planning Malaysia*, 20(5), 328 – 339.

Van Dyck, D., Cardon, G., Deforche, B., Owen, N., & De Bourdeaudhuij, I. (2011). Relationships between neighborhood walkability and adults' physical activity: How important is residential self-selection?. *Health & place*, *17*(4), 1011-1014.

Van Oers, J. A., & Reelick, N. F. (1992). Quantitative indicators for a healthy city--the Rotterdam local health information system. *Journal of Epidemiology & Community Health*, *46*(3), 293-296.

Visscher, H., Meijer, F., Majcen, D., & Itard, L. (2016). Improved governance for energy efficiency in housing. *Building Research & Information*, *44*(5-6), 552-561.

Webster, P., & Sanderson, D. (2013). Healthy cities indicators—a suitable instrument to measure health?. *Journal of Urban Health*, *90*, 52-61.

Wilmoth, M. J., Menozzi, M. C., & Bassarsky, M. L. (2022). Why population growth matters for sustainable development. Department of Economics and Social Affairs, United Nations.

World Health Organization. (2016). Health as the pulse of the new urban agenda: United Nations conference on housing and sustainable urban development, Quito, October 2016.

Zyed, Z. A. S., Tedong, P. A., Wan Abd Aziz, W. N. A., & Hanif, N. R. (2021). Governing Housing Affordability Problems among Younger Working Households. *Malaysian Construction Research Journal*, *Special Issue 12*(1), 118–128.

Received: 7th June 2023. Accepted: 5th September 2023

PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 21 ISSUE 5 (2023), Page 432 – 446

RESEARCH ON THE SPATIAL DISTRIBUTION OF PUBLIC SERVICE FACILITIES IN NANCHANG OLD CITY, CHINA BASED ON POINT OF INTEREST (POI) DATA

Wang Xueqiang[1], Mimi Zaleha Abdul Ghani[2], Gu Yuan[3], Nurulhusna Qamaruz Zaman[4], Yazid Sarkom[5]

[2,4,5] *College of Built Environment,*
UNIVERSITI TEKNOLOGI MARA, MALAYSIA
[1,3] *Architecture & Design College,*
NANCHANG UNIVERSITY, CHINA

Abstract

In recent years, Nanchang City has focused on urban renewal, including the transformation of old residential areas. The spatial layout of various public service facilities in the city has also undergone significant changes. To improve the public service facility system, it is essential to analyse the spatial layout of various service facilities in the old city area. The Geographic Information System (GIS) technology combined with Point of Interest (POI) data was to analyse the spatial distribution characteristics, thereby drawing the following conclusions: Nanchang's old urban area has less public service facilities in the edge area, and the spatial layout presents an imbalanced trend of "central aggregation - edge dispersion." The density of various facilities around the subway is good, educational, and cultural facilities is highly correlated with other types of facilities. However, medical facilities and other infrastructure are in a state of obvious differentiation, especially in the edge areas. The above analysis proposed for relevant strategies and recommendations, thus providing a basis for future scientific arrangement of urban facilities.

***Keywords**:* GIS, Public Service Facilities, Spatial Layout, POI Data

[2] Senior Lecturer at Universiti Teknologi MARA, Malaysia. Email: mzaleha@uitm.edu.my

INTRODUCTION

According to the 2022 "14th Five-Year Plan for Public Service" in China, it is indicated that the National Development and Reform Commission and several other related departments clarified the goals, tasks, paths, and measures for the development of public service systems for the new era. Urban public service facilities are the basic guarantee for citizens' daily lives, covering various purposes of facilities such as education, culture, medical, fitness, transportation, and commercial services. Scientific, rational planning and arrangement of urban public service facilities contribute to the improvement and perfection of the public service system, as well as promote high-quality developments of urban facilities, further enhancing the sense of gain, happiness, and security of the people. To improve the layout defects of facilities in Nanchang and to compare it with an international renowned city, as well as to learn from its urban construction, this research undertakes a comparative study by investigating the spatial distribution characteristics of public service facilities in Hong Kong.

RESEARCH BACKGROUND

Research on Urban Public Service Facilities Based on Data Analysis

Cheng Shunqi et al. (2016) have shown that research on urban public service facilities began in the 1950s when international scholars focused on the location selection of residential public service facilities using modern location theory with more emphasis on pursuing social benefits. In recent years, data analysis has been increasingly applied in the analysis of urban public service facilities. In the study of public facilities in urban communities, Osumanu I. K. (2013) conducted an analytical study to assess the accessibility and utilisation of public toilet facilities in Wa, Ghana, which showed that there is a deficiency in the spatial distribution of public toilets in the city, as these facilities are concentrated only in the central areas of the town. In addition, the study revealed that such public facilities should not be resource-intensive but should consider urban sanitation needs. Ballester, Nicholas et al. (2014) used actual shopping data to explore whether the layout of urban retail commercial facilities is influenced by traffic density and travel distance which showed that sectors with a high proportion of purchases do not necessarily need to be in locations with a high concentration of foot traffic. Retail layout can also be profit-driven and not just dependent on walking distance. Rim Meziani et al. (2017) investigated the link between the spatial layout and configuration of urban shopping centres and pedestrian movement behaviour in Abu Dhabi city, UAE by using structural equation modelling (SEM) techniques. The study led to the conclusion that the popularity of shopping centres is positively related to both satisfaction with way finding and the location of mall facilities. Kiyashko G. A. (2017) described that the application of GIS technology in urban planning, including various methods of using vector data and raster data which are useful in solving applicability tasks for better decision-making, especially for detailed planning of urban public facilities in developing areas. Yang (2017) used index models and spatial auto-correlation analysis to find significant differences in the spatial distribution of urban public service facilities in Guangzhou. Ge P. et al. (2019) extracted outflow, inflow, net flow, and net flow ratio features from big data of human activities in terms of urban land use and urban planning to improve the accuracy and utilisation of urban spatial distribution. Chen and Li (2022) selected Dongying District as an example to explore the configuration level and compliance rate of public facilities within the "15-minute life circle."

Research on POI Data

Point of Interest is abbreviated as POI; in geographic information systems, it refers to any meaningful point on a map that is not geographically significant. A POI can be a house, a store, a mailbox, a bus stop, shops, bars, gas stations, hospitals, stations, and others (Haofei Long, 2018). Wang and Shijun (2012) reported that the spatial agglomeration and location characteristics of commercial facilities in Changchun can be explained based on the POI data analysed. Liu K, Qiu P, et al. (2020) proposed a new framework for extracting and understanding subway stations as cognitive areas in urban public service facilities based on POI, Investigating urban subway stations as spatial cognitive places in cities, based on Geographic Information System (GIS) technology, 166 subway stations and more than 1 million POI data sources in Shenzhen, China, were studied to analyse the spatial location characteristics of urban subway stations and provide a human-centred perspective for the construction of urban public facilities. Currently, big data is prevalent, and GIS technology is widely used in urban spatial layout planning, and GIS provides new ways for spatial analysis and editing of urban data, as well as data management. Jang（2020）conducted a global comparative study on urban compactness using night-time lights data and POI (Points of Interest) big data. Various open-source datasets were utilised, including OSM's (Open Street Map), NTL (Night-time Lights), and POI data to identify the boundaries and cores of individual metropolitan areas, estimate net density, and measure the network distance (i.e., proximity to the nearest core). The findings suggest that densely populated cities in developed countries appear to have better proximity, while cities in developing countries exhibit the opposite trend.

However, at the current stage of urban renewal and transformation, there is relatively less research on the spatial distribution of public facilities in old urban areas. Therefore, taking Nanchang's old city as an example, based on POI data and using GS-related technology, this study analyses the current status of the spatial distribution of public service facilities in Nanchang's old city, clarifies the existing problems, provides a scientific reference for the future transformation and development of urban areas, as well as optimises the spatial distribution pattern of public service facilities in the old city.

Research Object

Nanchang City is an important provincial capital city in the middle and lower reaches of the Yangtze River, located in the northern part of Jiangxi Province. It is a famous historical and cultural city, with a total area of approximately 7,195 square kilometres. This study selects the old city of Nanchang (Figure 1) as the research area, which is mainly composed of the intersecting regions of Xihu District, Donghu District, Qingshanhu District, and Qingyunpu District. The area's boundaries extend from the Ganjiang River in the west, along River Avenue, to Hongcheng Road in the south, Hero Bridge in the north, and Hongdu Avenue in the east. According to the urban master plan data released by the urban planning management department of Nanchang City, it is evident that there have been significant changes in the spatial layout of various urban public service facilities in Nanchang City. These changes can be attributed to the continuous adjustments made to the city's administrative boundaries, as well as the rapid economic development witnessed in the past two decades. These transformations have had a profound impact on the distribution and arrangement of urban public service facilities, reflecting the dynamic nature of urban development in Nanchang City.

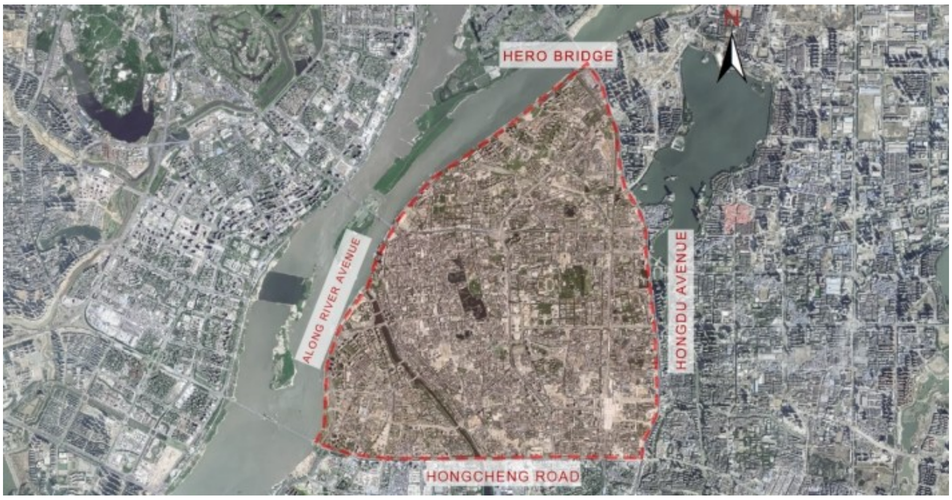


Figure 1: Map of the old city area of Nanchang
Source: Chinese Google Earth (2022)

Data Sources

The basic data for this study come from the open-source POI network data of public service facilities in the old city of Nanchang on Baidu Maps, where each POI data point corresponds to information such as the location and attribute category of the point of interest. According to the requirements of the "Urban Land Classification and Planning Construction Land Standards" the obtained data are organised into six major categories: commercial service facilities, administrative management facilities, medical and health facilities, financial service facilities, community public facilities, and educational and cultural facilities, as detailed in Table 1 (Wang Kai, 2012). A total of 20,392 points of interest were counted in the old city area, including 9,547 in Xihu District, 9,903 in Donghu District, 887 in Qingshanhu District, and 55 in Qingyunpu District, as shown in Table 2.

In ArcGIS software, the obtained POI data are visually analysed, using the WGS1984 coordinate system uniformly. The coordinate system of point attributes is made consistent with the map coordinates of the old city area of Nanchang, and the distribution maps of different categories of facility POI data are drawn (Figure 2).

Table 1: Classification of Public Service Facilities

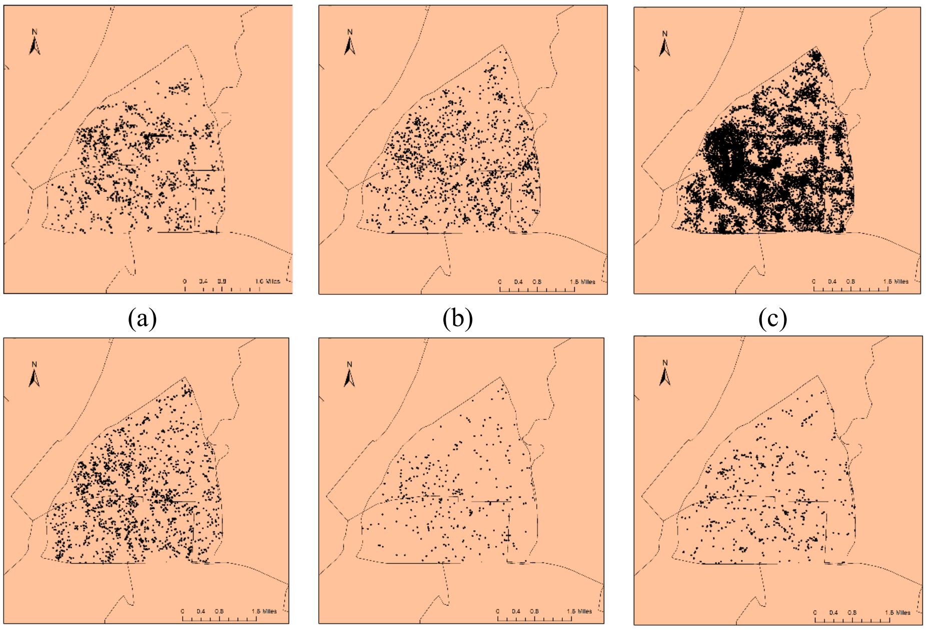
No	Category	Classification
1	Medical and Health Facilities	Hospitals, clinics, pharmacies, health centres, etc.
2	Educational and Cultural Facilities	Research institutions, schools, educational training, cultural centres, etc.
3	Commercial Service Facilities	Malls, convenience stores, wholesale markets, home appliance markets, etc.
4	Administrative Management Facilities	Government agencies, administrative departments, social organisations, etc.
5	Community Public Facilities	Newspaper halls, public toilets, etc.
6	Financial Service Facilities	Securities exchanges, financial insurance, major banks, etc.

Source: Author

Table 2: Distribution of Public Facilities POI in the Old City of Nanchang

Place	Medical & Health Facilities	Educational & Cultural Facilities	Commercial Service Facilities	Administrative Management Facilities	Community Public Facilities	Financial Service Facilities	Total
Xihu District	536	602	7030	956	134	289	9547
Donghu District	724	811	6804	1125	156	283	9903
Qingshanhu District	49	89	621	93	12	25	887
Qingyunpu District	2	3	48	1	0	1	55
Total	1311	1503	14503	2175	302	598	20392

Source: Author



(a) (b) (c)
(d) (e) (f)

Figure 2: Map of the old city area of Nanchang: (a) Medical and Health Facilities; (b) Educational and Cultural Facilities ;(c) Commercial Service Facilities; (d) Administrative Management Facilities; (e) Community Public Facilities; and (f) Financial Service Facilities
Source: Author

Research Methods

In the field of spatial analysis, "Average Nearest Neighbour" denotes the mean of the minimal inter-point distances within a given dataset. The methodology underlying this metric involves assessing spatial structure by juxtaposing the computed mean distance among proximate neighbour pairs against the corresponding mean distance as exhibited within a theoretical randomly distributed pattern. This comparative analysis facilitates an understanding of the real-world spatial distribution, as it allows for discerning whether the configuration of points is dispersed, clustered, or essentially random in nature.

Kernel Density Estimation (KDE) constitutes an analytical tool designed to scrutinise the spatial agglomeration of objects of interest. By applying a smoothing process to point-based data, KDE computes the density of pertinent attributes within their immediate vicinities. This technique is particularly instrumental when employed to dissect the density of amenities within a specified geographical area, thereby providing insightful perspectives on spatial patterns and distributions.

Average Nearest Neighbour Analysis Method

The nearest neighbour analysis represents the random distribution characteristics of features within a region (Yunlong, 2012). The aggregation characteristics of public service facilities in the old city area of Nanchang can be obtained through the average distance ratio of the average nearest neighbour method. By calculating the centroid distance between each element and its nearest neighbour element, the spatial pattern can be determined, and the P-value can be obtained. Comparing the Z-score with the critical value can determine the probability of random distribution, thereby judging the characteristics of the aggregation and dispersion of public facilities. The calculation formula is as follows:

$$D_O = \frac{1}{2}\sqrt{\frac{N}{A}} \quad (1)$$

In the formula, D_o represents the average distance of point features under random distribution, N is the number of selected features within the range, and A represents the area of the research region.

Kernel Density Analysis Method

Kernel density analysis is used to reflect the relative concentration of features in spatial distribution (Jiang Shiguo, 2009). The kernel density analysis calculates the density expansion value of facility points of interest in their surrounding neighbourhoods. The closer the distance between the elements, the higher the degree of mutual correlation, and the closer to the core element, the greater the density expansion value. The calculation formula is as follows:

$$F_{\mathrm{i}} = \frac{1}{n\pi R^2} \times \sum_{j}^{n} K_j (1 - \frac{D_{ij}^2}{R^2})^2 \quad (2)$$

F_{i} represents the kernel density of the *i-Th* facility point in the research area, *R* is the bandwidth of the selected regular area, and the *K* function is the spatial weight function; D_{ij} is the distance between facility point *i* and research object *j* ($D_{ij} < R$, when D_{ij} reaches a certain value, $R = 0$); *n* is the number of research objects *j* within the bandwidth *R* range.

RESULTS AND ANALYSIS

Spatial Agglomeration and Dispersion Characteristics of Public Service Facilities in Nanchang Old City Area

The POI data of various types is imported into ArcGIS to calculate the average nearest neighbour ratio parameter results for various types of public service facilities in Nanchang City. The agglomeration and dispersion pattern characteristics of urban public service facilities can be determined through the relevant results data. By importing the POI (Point of Interest) data of various facilities into ARCGIS for analysis, relevant index values of Average Nearest Neighbour zare obtained (Table 3). Based on the distribution characteristics of Average Nearest Neighbour, feature values can be categorised into three forms: Clustered, Random, and Dispersed. By comparing the data values from this study with the standard values (Figure 3), it can be concluded that the nearest neighbour ratios of these six types of public service facilities are all less than 1, and the *p* values are all 0, indicating that various service facilities are agglomerated in Nanchang City. The *z* scores are all less than the critical value of –2.58, indicating that the random distribution probability of various facilities is less than 1% and the degree of agglomeration of financial service facilities is much higher than that of other service facilities. According to the inverse relationship between the size of the nearest neighbour ratio and the degree of agglomeration, the smaller the ratio value, the greater the degree of aggregation. Comparing the nearest-neighbour ratios of the six types of public service facilities in Table 3, the degrees of agglomeration and dispersion from small to large are community public facilities, educational and cultural facilities, medical and health facilities, commercial service facilities, administrative management facilities, and financial service facilities.

Table 3: The Average Nearest Neighbour of Public Service Facilities in the Old City of Nanchang

Facilities	Average observation distance	Expected average distance	Nearest neighbour ratio	*Z* score	*P* value
Medical and Health Facilities	46.7054	73.4516	0.635866	–25.222819	0
Educational and Cultural Facilities	48.4945	73.9325	0.655929	–25.51871	0
Commercial Service Facilities	14.0619	24.3677	0.577070	–97.438028	0
Administrative Management Facilities	33.0897	62.5389	0.529105	–42.013051	0
Community Public Facilities	129.4887	163.8744	0.790171	–6.97591	0
Financial Service Facilities	51.4043	114.2548	0.449909	–25.734519	0

Source: Author

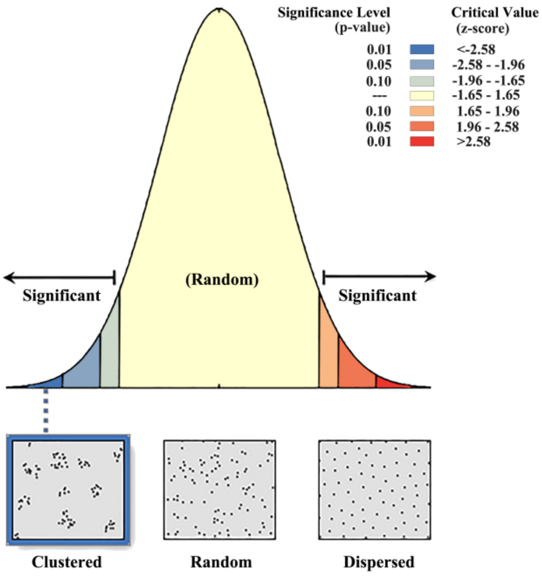


Figure 3: Map of Average Nearest Neighbour Distribution Characteristic Index
Source: Author

Kernel Density Analysis of Public Service Facilities in Nanchang Old City

To reflect more intuitively the spatial configuration characteristics of various types of public service facilities in Nanchang Old City, the kernel density analysis method is used to analyse the six types of public service facilities. The darker the regional colour, the larger the kernel density value, and the more concentrated the distribution. The results are shown in figure 4.

（1）Kernel Density Analysis of Medical and Health Facilities: As an important part of a healthy city's construction and an increasingly needed infrastructure for people's livelihood, the distribution characteristics of medical facilities in Nanchang Old City are shown in Fig 4a. The distribution features are clearly clustered in the old city area, with high facility density in the north-central part of the city. However, the clustering degree is low in the relatively marginal areas, and the medical service area in the marginal areas is too wide, causing inconvenience for residents' lives.

（2）Kernel Density Analysis of Educational and Cultural Facilities: The analysis of educational and cultural facilities in Nanchang Old City, including training institutions, various schools, and cultural facilities, is shown in Fig 4b. In Nanchang Old City, the educational and cultural facilities are mainly primary and secondary schools. The radiation range of education still has a certain distance. The clustering degree is evident in the boundary area between Xihu District, Donghu District, and Qingshanhu District, as it is basically located in the city centre with good educational resources, forming a high-density clustering area.

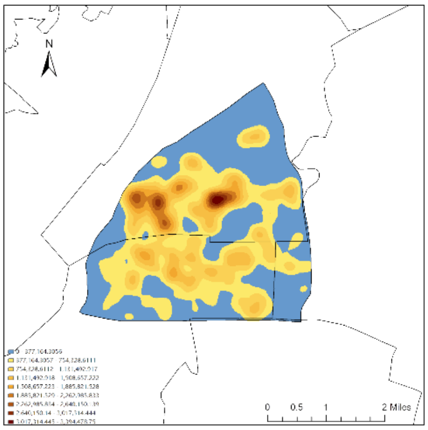
（3）Kernel Density Analysis of Commercial Service Facilities: Commercial service facilities are one of the services most closely related to residents' lives. The distribution of commercial service facilities, as shown in Figure 4c, mainly includes large shopping malls, supermarkets, convenience stores, and wholesale markets. The commercial density is high in the areas where Xihu District and Donghu District intersect, and the most concentrated area is around the Bayi Square. At the same time, there are multiple subway lines running through the old city, and the overall distribution of commercial facilities is well-equipped. In comparison with educational and cultural facilities, many commercial locations are in areas with abundant educational resources. The site selection of commercial service facilities is closely related to the flow of people.

（4）Kernel Density Analysis of Administrative Management Facilities: Compared to other service facilities, this type of facility has a certain degree of authority and is restrictive in its layout. The analysis result is shown in Fig 4d. According to the overall development of Nanchang City, the administrative management service facilities in Donghu District and Xihu District of the old city are densely distributed, with multiple concentrated points.

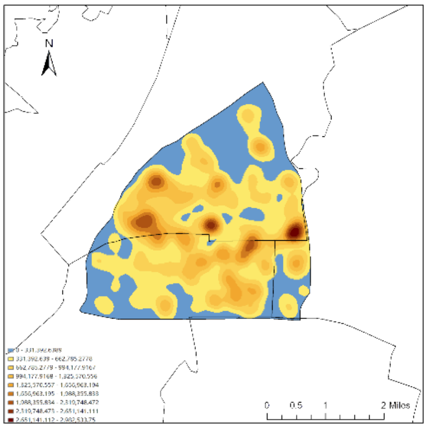
Under the current trend of urban renewal, there is an urgent need for comprehensive adjustments and considerations.

（5）Kernel Density Analysis of Community Public Facilities: The analysis results from Fig 4e. show that the distribution in the old city area is relatively concentrated, mainly including public toilets, newspaper kiosks, and other public places. The density value in Donghu District of the old city is the highest, showing a ring-shaped density distribution. After a series of urban renewal and transformation, public facilities have been improved. However, the density in Qingshanhu District and Qingyunpu District is relatively average, and further improvements are needed for such service facilities in the peripheral areas.

（6）Kernel Density Analysis of Financial Service Facilities: An Analysis of Financial Service Facilities in the Old City Area of Nanchang City, as shown in Figure 4f. Due to the economic transformation of Nanchang City's important economic hub, the financial industry in the old city area is shifting towards the development of new areas to alleviate the pressure on the economy and population. As a result, the distribution of financial service facilities in the old city area is unevenly distributed.



(a)



(b)

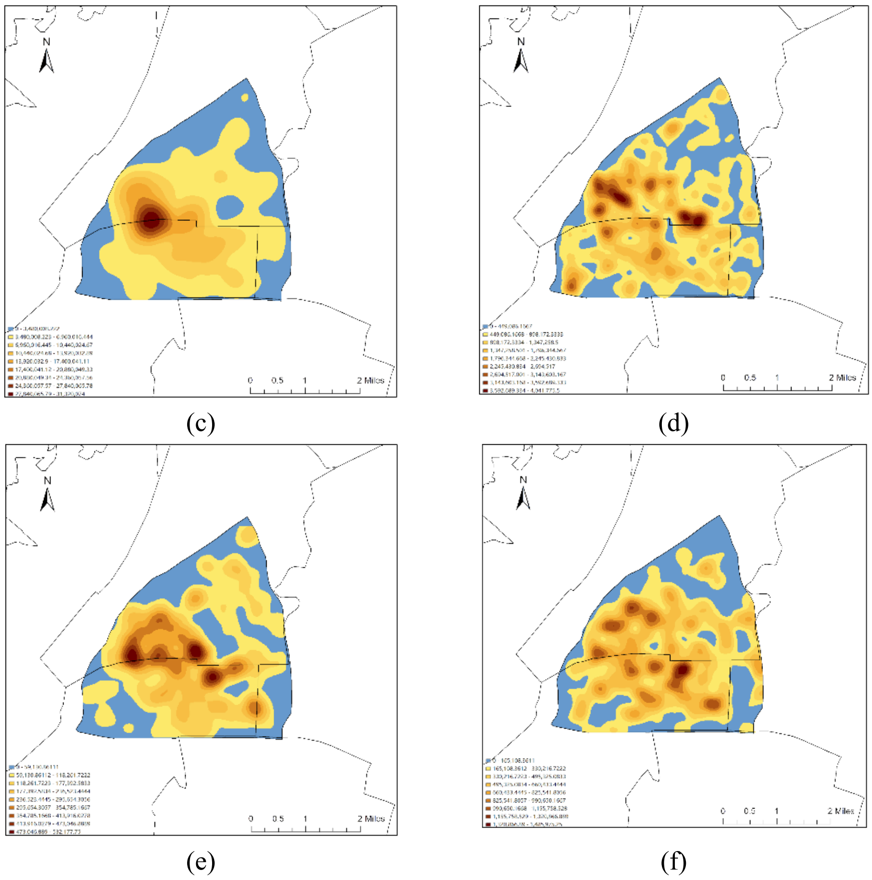
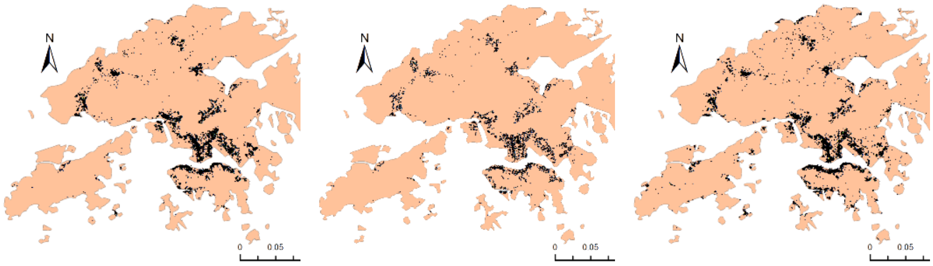


Figure 4: Kernel Density Map of Various Public Service Facilities in Nanchang Old City Area (a) Medical and Health Facilities; (b)Educational and Cultural Facilities;(c) Commercial Service Facilities; (d)Administrative Management Facilities; (e)Community Public Facilities; (f)Financial Service Facilities
Source: Author

A Comparative Analysis of Various Public Facilities Distribution in Hong Kong

This research undertakes a comparative study by investigating the spatial distribution characteristics of public service facilities in Hong Kong, a city renowned on an international scale. This analysis serves to establish connections and draw parallels with the urban context of Hong Kong, fostering a deeper understanding of the spatial patterns and arrangements of these vital amenities to discover the gaps and shortcomings in the layout of public facilities of Nanchang city. This is carried out by focusing on the medical and health facilities, educational and cultural facilities, and commercial service facilities in Hong

Kong as comparative data. It involved 13,718 medical and health facilities, 3,060 educational and cultural facilities and 21,349 commercial service facilities that were selected. The specific distribution is shown in Figure 5.

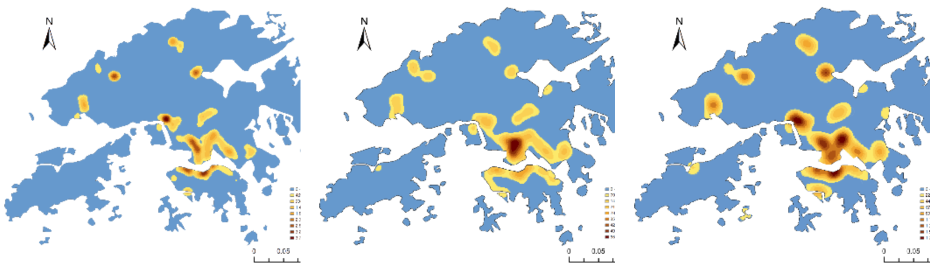


(a) (b) (c)

Figure 5: Distribution map of public service facilities in Hong Kong (a) Medical and Health Facilities; (b)Educational and Cultural Facilities;(c) Commercial Service Facilities

Source: Author

The spatial distribution pattern characteristics of the three types of urban public facilities in Hong Kong are analysed by using the kernel density analysis method and the results are shown in Figure 6. From the analysis results, it is observed that the layout of medical and health facilities, educational and cultural facilities and commercial service facilities in Hong Kong are all relatively concentrated, and there is a large intersection of the kernel density range, demonstrating a close relationship between the three. This analysis reflects the relative concentration of various urban resources in Hong Kong and the concurrent development of various facilities that is more balanced among them.



(a) **(b)** **(c)**

Figure 6: Kernel Density Map of Various Public Service Facilities in Hong Kong: (a) Medical and Health Facilities; (b) Educational and Cultural Facilities; and (c) Commercial Service Facilities

Source: Author

CONCLUSION

Through the multidimensional analysis of the spatial distribution characteristics of public service facilities in the old city area of Nanchang City using POI basic data and GIS technology, this study provides relevant theoretical support for the optimisation of urban public service facilities and the high-quality development of the city in the next stage. The main conclusions are as follows:

（1）Due to the historical development of the city, public service facilities in various categories are relatively concentrated in the old city area of Nanchang, with a high degree of agglomeration. However, there are fewer public service facilities in the peripheral areas of the old city area, and the spatial layout presents an imbalanced trend of "central aggregation - edge dispersion".

（2）With the acceleration of subway transportation construction in Nanchang City, multiple subway lines have been opened and are connected to the old city area, where the density of various facilities around the subway is good, especially for commercial facilities. In the subway sections where a new city planning has not yet been developed, corresponding commercial density and the evacuation of crowds should be considered to truly alleviate various pressures in the old city area.

（3）The spatial layout of education and cultural facilities is highly correlated with other types of facilities. From the analysis results, we find that education and commercial facilities are closely related. There are many university campuses in the old city area of Nanchang, and commercial facilities can meet the needs of students in learning and other aspects, while driving the economic development of the old city area. However, the location of commercial facilities should consider on the effect on university campuses.

（4）There is an obvious differentiation in the spatial layout of infrastructure such as medical facilities and community public facilities, suggesting that the peripheral areas of the old city area lack basic infrastructure. In the current trend of developing healthy cities, the construction of medical and health infrastructure should be improved to meet the daily needs of residents along with other facilities to enhance their life satisfaction and happiness.

ACKNOWLEDGEMENTS

This research was supported by College of Built Environment of Universiti Teknologi MARA, Malaysia and Urban Renewal Studio of Architecture & Design College of Nanchang University, China.

REFERENCES

Ballester, N., Guthrie, B., Martens, S., Mowrey, C., Parikh, P. J., & Zhang, X. (2014). Effect of retail layout on traffic density and travel distance. In *IIE Annual*

Conference. *Proceedings* (p.798). Institute of Industrial and Systems Engineers (IISE).

Chen Lufeng, Li Chengming, Dai Zhaoxin, & Zhang Hongri. (2022). Research on the configuration of public service facilities in residential areas "15-minute living circle". *Science of Surveying and Mapping* (001),047.

Cheng Shunqi, Qi Xinhua, Jin Xingxing, Li Damou&Lin Han (2016) Research progress on the spatial layout of public service facilities both domestically and internationally.*Tropical Geography* (01), 122-131

Ge, P., He, J., Zhang, S., Zhang, L., & She, J. (2019). An integrated framework combining multiple human activity features for land use classification. *ISPRS International Journal of Geo-Information*, 8(2), 90.

Hao Feilong, Wang Shijun, Feng Zhangxian, Yu Tingting, & Ma Li. (2018). Commercial space pattern and industry distribution in Changchun based on POI data. *Geographical Research*, 37(2), 366-378.

Jang, C. H., & Song, J. (2020). Do High-Density Cities Have Better Proximity?: Global Comparative Study on Urban Compactness Using Nighttime Light Data and POI BIG Data. *Journal of Korea Planning Association*-Vol, 55(6), 5-20.

Jiang Shiguo, Teng Junhua, & Wang Fahui. (2009). Quantitative Methods and Applications Based on GIS. *Beijing: Commercial Press*.

Kiyashko, G. A. (2017, November). Application of GIS Technology for Town Planning Tasks Solving. *In IOP Conference Series: Materials Science and Engineering* (Vol. 262, No. 1, p. 012112). IOP Publishing.

Liu, K., Qiu, P., Gao, S., Lu, F., Jiang, J., & Yin, L. (2020). Investigating urban metro stations as cognitive places in cities using points of interest. *Cities*, *97*.

Meziani, R., & Hussien, H. A. (2017). A study on the space layout and configuration of shopping malls in relation to pedestrian movement behavior-case of UAE.*International review for spatial planning and sustainable development*, 5(3), 53-65.

Osumanu, I. K., & Kosoe, E. A. (2013). Where do I answer nature's call? An assessment of accessibility and utilisation of toilet facilities in Wa, *Ghana. Ghana journal of Geography*, 5, 17-31.

Wang Kai, & Xu Ying. (2012). Urban Land Classification and Planning Construction Land Standards (GB 50137-2011) Q&A (1). *Urban Planning*, v.36; No.297(05), 80-84.

Zhao Yang. (2017). Research on the Fairness of Public Service Facilities Layout under the Background of Urban Renewal: A Case Study of Primary School Distribution in Longhua District, Shenzhen. *Sustainable Development and Rational Planning——Proceedings of the 2017 China Urban Planning Annual Conference (02 Urban Renewal)*.

Received: 24th July 2023. Accepted: 15th August 2023

NOTES TO CONTRIBUTORS AND GUIDELINES FOR MANUSCRIPT SUBMISSION

INTRODUCTION

The Journal of the Malaysian Institute of Planners or PLANNING MALAYSIA is a multidisciplinary journal related to theory, experiments, research, development, applications of ICT, and practice of planning and development in Malaysia and elsewhere.

The objective of the journal is to promote the activity of town planning through dialogue and exchange of views concerning professional town planning practice. PLANNING MALAYSIA will welcome any news, feature articles, or peer reviewed (including book reviews, software review, etc.) articles for publication. All articles should be original work by the authors. **Articles, views and features will not be taken to be the official view of the Malaysian Institute of Planners (MIP) unless it carries the name of MIP as the author.** This is to encourage open discussion on diverse issues and opinion for the advancement of town planning practice. Articles and contributions will be accepted from MIP members and non-members worldwide.

In year 2010, PLANNING MALAYSIA Journal has been indexed in SCOPUS. Previous issues of PLANNING MALAYSIA Journal can be viewed on the MIP website.

SUBMISSION OF MANUSCRIPTS

Manuscript should be emailed to pmjournal@gmail.com. Manuscript should ideally be in the range of 8-10 pages long. Each manuscript should have a title page and an abstract of about 150 words. The title page should contain the title, full name(s), designation(s), organizational affiliation(s), a contact address, and an email address. All manuscripts are received on the understanding that they are not under concurrent consideration at another journal. One copy of the current Journal will be provided for each article. Additional reprints of article can be ordered, at cost, by the author(s). PDF format of the article (if available) can be obtained from the Publisher.

LAYOUT

Manuscript should be typed in single spacing (including footnotes, endnotes and references) on one side of the paper only (preferably A4) with the following margins: right and left - 4.25 cm, top - 5.5 cm and bottom - 5.2 cm (including header – 4.5 cm and footer – 4.3 cm) in 11 point Times New Roman font. Footnotes should be numbered consecutively and placed at the end of the manuscript. Footnotes should be kept to a minimum. Tables and diagrams should be provided in the text. References should follow the APA (6th Edition) referencing format. All foreign words must be typed and transliterated. The Editorial Board reserves the right to change the transliteration of all historical names, titles and non-English terminology to bring them into conformity with its own style.

USE OF FORMULA, FIGURES AND TABLES

Formula (mathematical formula) should be used only when necessary and the CONCLUSION derived must be explained and made intelligible to a non-mathematical reader. Wherever possible, authors are encouraged to place the mathematical parts of the article in an appendix. In cases of empirical articles, authors are expected to make readily available a complete set of data and any specialized computer programs to interested readers.

All illustrations, figures and/or tables in the manuscript must be captioned, in clear black and white (grayscale) and ready for reproduction.

REFEREEING PROCEDURE

Manuscripts will be acknowledged upon receipt. Only selected (preferred) manuscripts will be **reviewed by two (or three) referees** in addition to the editors. Editorial decision will normally be made within **two to six months**, but circumstances beyond control occasionally dictate a longer cycle. If authors are invited to prepare a revision for further consideration, the major issues to be resolved will be outlined and will be forwarded to them as quickly as possible.

ACCEPTED ARTICLES

Authors of accepted articles will be requested to provide a digital copy of the manuscript, preferably in Microsoft Word to the MIP (the Publisher) via email at pmjournal@gmail.com. MIP will not be responsible for the loss or damage of the digital copy.

COPYRIGHT

Copyright & Creative Commons Licence
eISSN: 0128-0945 © Year. The Authors. Published for Malaysia insititute of planner.
This is an open-access article under the CC BY-NC-ND license.

The authors hold the copyright without restrictions and also retain publishing rights without restrictions.

Contact:

Editor-in-Chief
PLANNING MALAYSIA
Journal of the Malaysian Institute of Planners
B-01-02, Jalan SS7/13B, Aman Seri, Kelana Jaya,
47301, Petaling Jaya, Selangor Darul Ehsan, MALAYSIA
Tel: +603 78770637 Fax: +603 78779636
Email: pmjournal@gmail.com
Homepage: www.planningmalaysia.org

ETHIC STATEMENT

The Journal of the Malaysia Institute of Planners or **PLANNING MALAYSIA** is a peer-reviewed journal. This statement spells out ethical behaviour of all parties involved in the act of publishing an article for this journal, i.e. the author, the peer-reviewer, the chief editor and editors, and the publisher. This statement is based on COPE's Best Practice Guidelines for Journal Editors. URL: http://publicationethics.org/files/u2/Best_Practice.pdf

DUTIES OF AUTHORS

Reporting Standards

Authors of original research should present an accurate account of the work done as well as an objective discussion of its significance. Data of the research should be represented accurately in the article. An article should contain sufficient detail and references to permit others to replicate the work. Fraudulent or knowingly inaccurate statements constitute unethical behaviour and are unacceptable.

Data Access and Retention

Authors may be asked to provide the raw data in connection with an article submitted for editorial review, and should be prepared to provide public access to such, if practicable, and should in any event be prepared to retain such data for a reasonable time after publication.

Originality and Plagiarism

Authors should ensure that they have written entirely original works, and if the authors have used the work and/or words of others this must be appropriately cited or quoted. Such quotations and citations must be listed in the Reference at the end of the article.

Multiple Publication

An author should not in general publish manuscripts describing essentially the same research in more than one journal or primary publication. Submitting the same manuscript to more than one journal concurrently constitutes unethical publishing behaviour and is unacceptable.

Acknowledgment of Sources

Proper acknowledgment of the work of others must always be given. Authors should cite publications that have been influential in determining the nature of the reported work.

Authorship of the Paper

Authorship should be limited to those who have made a significant contribution to the conception, design, execution, or interpretation of the study, and should be listed as co-authors. Others who have participated in certain substantive aspects of the research project, they should be acknowledged or listed as contributors.

Corresponding Author
Corresponding author is the author responsible for communicating with the journal for publication. The corresponding author should ensure that all appropriate co-authors and no inappropriate co-authors are included on the paper. All co-authors have seen and approved the final version of the paper and have agreed to its submission for publication.

Acknowledgment of Funding Sources
Sources of funding for the research reported in the article should be duly acknowledged at the end of the article.

Disclosure and Conflicts of Interest
All authors should disclose in their manuscript any financial or other substantive conflict of interest that might be construed to influence the results or interpretation of their manuscript.

Fundamental Errors in Published Works
When an author discovers a significant error or inaccuracy in his/her own published work, it is the author's obligation to promptly notify the journal editor or publisher and cooperate with the editor to retract or correct the paper.

DUTIES OF REVIEWERS

Contribution of Peer Review
Peer review assists the chief editor and the editorial board in making editorial decisions while editorial communications with the author may also assist the author in improving the paper.

Unqualified to Review or Promptness
Any reviewer who feels unqualified to review the assigned manuscript or unable to provide a prompt review should notify the editor and excuse himself/herself from the review process.

Confidentiality
Manuscripts received for review must be treated as confidential documents. They must not be shown to, or discussed with, others except as authorized by the chief editor. Privileged information or ideas obtained through peer review must be kept confidential and not used for personal advantage.

Standards of Objectivity
Reviews should be conducted objectively. There shall be no personal criticism of the author. Reviewers should express their views clearly with supporting arguments.

Acknowledgment of Sources
Reviewers should identify relevant published work that has not been cited by the authors. Any statement that had been previously reported elsewhere should be accompanied by the relevant citation. A reviewer should also call to the chief editor's attention any

substantial similarity or overlap between the manuscript under consideration and any other published paper of which they have personal knowledge.

Conflict of Interest
Reviewers should decline to review manuscripts in which they have conflicts of interest resulting from competitive, collaborative, or other relationships or connections with any of the authors.

DUTIES OF EDITORS

Decision on the Publication of Articles
The chief editor of the PLANNING MALAYSIA is responsible for deciding which of the articles submitted to the journal should be published. The chief editor may be guided by the policies of the journal's editorial board subjected to such legal requirements regarding libel, copyright infringement and plagiarism. The chief editor may confer with other editors or reviewers in making this decision.

Fair play
Manuscripts shall be evaluated solely on their intellectual merit.

Confidentiality
The chief editor/editors and any editorial staff must not disclose any information about a submitted manuscript to anyone other than the corresponding author, reviewers, potential reviewers, other editorial advisers, and the publisher.

Disclosure and Conflicts of Interest
Unpublished materials disclosed in a submitted manuscript must not be used by anyone who has a view of the manuscript while handling it in his or her own research without the express written consent of the author

PLANNING MALAYSIA
JOURNAL OF THE MALAYSIAN
INSTITUTE OF PLANNERS

B-01-02, Jalan SS7/13B, Aman Seri, Kelana Jaya,
47301, Petaling Jaya, Selangor Darul Ehsan, MALAYSIA
Tel: +603 78770637 Fax: +603 78779636
Email: pmjournal@gmail.com or mip@mip.org.my
Website: www.planningmalaysia.org

ISSN 16756215
9 771675 621005