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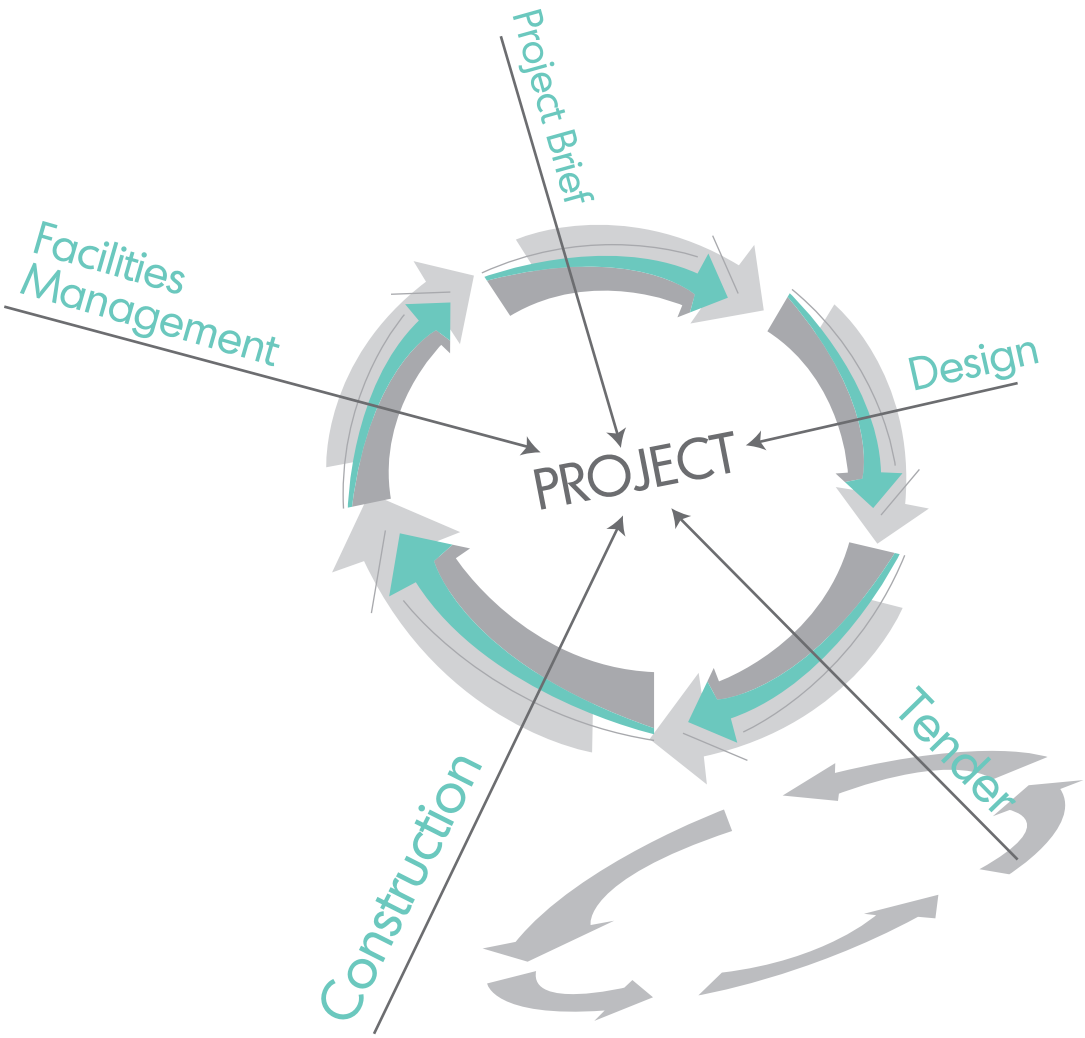

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Editorial

Welcome from the Editors

Welcome to the thirty-eighth (38th) issue of Malaysian Construction Research Journal (MCRJ). In this issue, we are pleased to include eight papers that cover a wide range of research areas in the construction industry. The editorial team would like to express our sincere gratitude to all contributing authors and reviewers for their contributions, continuous support and comments.

In this issue:

Sandra Cunha et al., investigated the physical and mechanical properties of compressed earth bricks (CEBs) stabilised with Portland cement and activated with phase change material (PCM) using a typical soil of the north region of Portugal. Evaluation on compression strength, deformation, water absorption, erosion and thermogravimetry of blocks with 25%, 50% and 75% direct incorporation of non-encapsulated PCM. It can be concluded that the compressed earth blocks with the incorporation of non-encapsulated PCM showed a compressive strength higher than the minimum strength established in several countries.

Kudrekodlu Venkatesh Prasad et al., identified the impact of an urban metro rail project on real estate rental values. A survey has been used as the methodology within two zones: one zone within a 500m radius of the metro rail station and the second one with properties located at a radius more than 500m from the metro rail station. The questionnaire involved three (3) main attributes: physical, location, and Neighbourhood & Environmental. The hedonic regression method was used as part of the analysis, and the findings show that the real estate value is higher in properties close to the metro station than in properties far away from the metro station.

Muhamad Hafizuddin Idris et al., assessed the risk factors of civil engineering projects in the Malaysian construction industry. The methodology adopted was a survey questionnaire involving 350 respondents among G7 contractors registered with CIDB. The findings show that construction delay, late payment by the client, unavailability of funds, poor communication among construction parties, and coordination of works among construction were the common risk factors in risk mitigation and had significant impacts on their projects. Therefore, all risk factors must be determined, identified, classified, and assessed against their impact and likelihood.

Abdul `Izz Mohd Kamil et al., explored the contractor's barriers in conducting strategic decisions in tendering. A survey questionnaire was distributed to the 60 respondents to achieve the study's objectives. The results obtained were ranked based on the mean of the challenges listed in the questionnaire. The findings show that excessive eagerness to win a project is the highest mean, followed by insufficient qualified technical staff, insufficient time, and limitation of data. The least mean is management practice. The study also suggests that components such as knowledge, financial, stability of the company, and market condition should be included in deciding to tender.

Noor Aisyah Asyikin Mahat et al., determined the crucial management strategies to improve productivity in Green Construction Projects (GCP). The methodology used in this study is a survey questionnaire to the professional engineers registered under the Board of Engineer Malaysia (BEM) and Grade G7 contractors registered with the Construction Industry Development Board (CIDB). The findings from Exploratory Factor Analysis (EFA) have grouped five (5) main components: Government Regulation & Policies, Workforce Development, Project Management and Administration, Innovative Construction Technology and Technique Adoption and Effective Site Management.

Mysarah Maisham et al., discovered the main barriers to Life Cycle Costing (LCC) implementation in Malaysia's green construction projects. The quantitative research method has adopted through a survey questionnaire to the 700 respondents. Descriptive statistics were used to rank the listed barriers, and the finding shows that the client's unwillingness to pay more for LCC exercise was the main barrier. It was followed by a lack of guidelines to assist in understanding how LCC calculations are done. The least agreement results from LCC analysis are difficult to interpret and not directly useful.

Farrah Norizzah Mohd Yussof et al., revealed the safe city initiatives (SCI) among Local Authorities (LA) in Selangor. The five (5) local authorities' representatives at the city council, municipal, and district levels of 5 different zones in Selangor adopted the qualitative research method. The findings show the pattern of safe city implementation initiatives within the level of authority of the city, municipal, and district levels. There are three (3) strategy initiatives for a safe city: environmental design initiatives, target hardening and Management, community involvement, and public awareness.

Wan Norizan Wan Ismail et al., resolute the significant factors influencing the delay in issuing civil engineering project information. A mixed method was adopted in this study involving survey questionnaires and semi-structured interviews with professional civil engineers and G7 contractors. The result shows that the main factor influencing the delay in issuing project information is scope changes followed by ground uncertainty. The least factor is the clarity of SFoC. The author suggested that procurement arrangement and contract that could effectively respond to the unpredictable ground and the surrounding conditions is important to be properly selected.

Editorial Committee

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A STUDY OF PHASE CHANGE MATERIAL (PCM) ON THE PHYSICAL AND MECHANICAL PROPERTIES OF COMPRESSED EARTH BRICKS (CEBs)

Sandra Cunha, André Campos, José Aguiar and Francisco Martins
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Abstract
Earth construction is an ancestral technique, which in recent years has attracted more attention due to its sustainability and low cost. Compressed Earth Blocks (CEBs) are a modern construction technique based in the ancient techniques of adobe and rammed earth. On the other hand, phase change materials (PCM) have been applied successfully in different products for the construction industry, due to their potential for regulation the temperature inside buildings. Thus, the association of these two techniques allows to obtain a constructive solution with all the advantages associated with earth construction, but also with a high impact on the energy efficiency of buildings. However, this is still an underdeveloped area with great research needs. In this work, CEBs were developed and characterized with direct incorporation of non-encapsulated PCM, having been evaluated different compositions in the fresh and hardened state. The main objective of this study was the development and physical and mechanical characterization of CEBs stabilized with Portland cement and activated with PCM, using a typical soil of the north region of Portugal. Having been evaluated the compression strength, deformation, water absorption, erosion and thermogravimetry of blocks with 25%, 50% and 75% direct incorporation of non-encapsulated PCM. It was possible to conclude that the incorporation of PCM in CEBs can be carried out successfully. The addition of a content of 10% of Portland cement and 25% of non-encapsulated PCM constitutes an advantageous solution in the performance of the developed CEBs from the physical, mechanical and durability point of view.

Keywords: *Sustainability; earth blocks; phase change materials.*

INTRODUCTION

Currently, there is an enormous pressure related to the sustainable construction of new buildings around the world. This came in part due to the growing public awareness and also due to the growing concern of the scientific community with the construction of more sustainable buildings. Thus, the development of new construction solutions based on ancestral construction solutions has become very interesting, such as earth construction.

Since a thousand of years, earth has been used as a building material in different civilizations all over the world. Currently, the earth construction is still very present in Africa, Latin America, Middle East and Indian subcontinent (Cottrell, Tatari & Martinson, 2021; Jannat, Hussien, Abdullah & Cotgrave, 2020). It is estimated that 40% of the world population lives in buildings built based in earth. However, in developing countries this number is higher, about 50%, in which at least 30% of the population lives in rural areas and the rest in urban or suburban areas (Jannat et al., 2020).

The earth construction presents several advantages, from the economic, energetic, environmental, social and cultural point of view. Its benefits are widely searched and known for offering a low-cost construction solution, the absence of specific equipment, low environmental impact, totally reusable, low carbon emission, low thermal conductivity and good hygroscopic characteristics. However, it also presents some disadvantages, such as low

mechanical strength, higher vulnerability to earthquakes, heterogeneous raw material, durability and vulnerability to erosion by rain (Cottrell et al., 2021; Jannat et al., 2020; Mansour, Ogam, Jelidi, Cherif & Jabrallah, 2017). Unfortunately, due to these disadvantages, the use of earthen building materials in the modern construction industry has been ignored for many years (Jannat et al., 2020).

Compressed Earth Blocks (CEBs) are a construction material, developed in modern times, which combines the ancient techniques of adobe and rammed earth. Instead of being molded or compacted by hand, such as adobe, the compressed earth blocks are formed by compressing a slightly moistened amount of soil, inside a mechanical steel press (Kasinikota & Tripura, 2021). This technique dates to the 18th century, with the appearance of the first manual press (Cottrell et al., 2021). Compared to adobes and other hand-molded blocks, CEBs are completely regular in size and shape, and much denser. These blocks are known as ecological bricks.

Compressed earth blocks can present very different characteristics according to their stabilization, and the compressive strength of unstabilized CEBs is much lower than the compressive strength of chemically stabilized CEBs, with cement or lime (Danso, Martinson, Ali & Mant, 2015; Turgut & Yesilata, 2008). Several authors worked on clay blocks stabilized with Portland cement and emphasized their higher strength and durability under different conditions (Kasinikota & Tripura, 2021; Morel, Pkla & Walker, 2007; Oti & Kinuthia, 2012; Walker, 1995). However, other stabilizers such as lime, gypsum and bitumen presented satisfactory results (Bogas, Silva & Gomes, 2019; Kasinikota & Tripura, 2021). Other studies, with the aim to improve earth-based materials thermal properties, have been developed, studied the impact of density on the hygrothermal properties (Cagnon, Aubert, Coutand & Magniont, 2014; Colinart et al., 2020; Medjelekh, Ulmet & Dubois, 2017; Niang et al., 2018; Tommerup & Svendsen, 2006).

There is a huge concern related with the energy consumption of buildings. The buildings energy consumption for heating and cooling is about 30% of the total energy consumption in the European Union and about 75% of the total energy consumption in buildings sector (Cunha & Aguiar, 2020). In recent years, new methods have been developed to improve the thermal behaviour of buildings, such as the incorporation of phase change materials (PCM) in construction solutions (Alassaad, Touati, Levacher & Sebaibi, 2021; Cunha & Aguiar, 2020; Cunha, Aguiar & Tadeu, 2016; Cunha, Silva & Aguiar, 2020a).

Phase change materials can reduce the heating and cooling needs of buildings, through their thermal storage capacity (Cunha & Aguiar, 2020; Cunha et al., 2016; Cunha, Leite & Aguiar, 2020b). Its incorporation in construction solutions has revealed very interesting results. In some studies, in addition to decreasing the climatization needs in all seasons, there was also an elimination of heating or cooling needs in the spring and autumn seasons (Cunha et al., 2016; Cunha et al., 2020b).

PCM can be incorporated into construction solutions for floors (Entrop, Brouwers & Reinders, 2011; Nagano, Takeda, Mochida, Shimakura & Nakamura, 2006), walls (Cabeza, Castell, Barreneche, Gracia & Fernández, 2011; Shilei, Neng & Guohui, 2006), ceilings (Koschenz & Lehmann, 2004; Pasupathy, Athanasius, Velraj & Seeniraj, 2008), glazed (Hussein et al., 2016; Khadiran, Hussein, Zainal & Rusli, 2016) and can also be part of more

complex thermal systems, such as heat pumps and solar panels (Bellos, Tzivanidis, Moschos & Antonopoulos, 2016; Lin et al., 2005; Lu, Xu & Tang, 2020). However, their applications in walls constitute the most interesting solution, due to the huge area of application of the material. This material was applied in mortars (Cunha, Aguiar, Ferreira & Tadeu, 2015), gypsum plasterboards (Oliver, 2012), bricks (Saxena, Rakshit & Kaushik, 2019) and concrete (Bahrar, Djamai, Mankibi, Larbi & Salvia, 2018).

There are different techniques for incorporating PCM in construction materials, such as encapsulation (microencapsulation (Bahrar et al., 2018; Cunha et al., 2016; Griffiths & Eames, 2007; Kheradmand, Azenha, Aguiar & Castro-Gomes, 2016; Kuznik, David, Johannes & Roux, 2008) and macroencapsulation (Castell, Martorell, Medrano, Pérez & Cabeza, 2010; Jin & Zhang, 2011; Pasupathy et al., 2008; Santos, Kolokotroni, Hopper & Yearley, 2019; Saxena et al., 2019) immersion (Shilei, Guohui, Neng & Li, 2007; Shilei et al., 2006), stabilization (Lin et al., 2005; Zhou, Zhang, Zhang, Lin & Di, 2007) and direct incorporation (Cunha et al., 2020a; 2020b). The most used PCM incorporation technique is the encapsulation, with high costs due to the encapsulation process of the PCM, representing an obstacle for the practical application of the technology. On the other hand, the direct incorporation is an undeveloped technique but very promising, due to the low cost of PCM and consequently the low cost of construction material activated with this material.

The challenge for reducing the impact of buildings during their lifetime requires new materials that are efficient, sustainable and reusable (Losini, Grillet, Bellotto, Woloszyn & Dotelli, 2021). Taking into account the construction sector high energy consumption and greenhouse gas emissions production, the development of new green building materials with better properties is becoming increasingly important (Jannat et al., 2020). Thus, the search for constructive solutions and functional construction materials becomes more and more interesting. The possibility of construction materials with a common aspect to perform specific functions such as the temperature control inside buildings is a promising path for the development of the construction industry. Thus, the PCM incorporation in compressed earth blocks is a step in obtaining functional construction technologies based on ancestral and environmentally friendly techniques. CEB's activated with PCM have a significant contribution to the construction sustainability, either because they use a natural raw material, present a low-cost production and environmental impact, and contribute to the minimization of buildings climatization energy consumption. Recently, the incorporation of PCM microcapsules in earth building materials has also attracted the interest of the scientific community (Alassaad et al., 2021). However, it is still an area with high and important knowledge gaps. This study is one of the first attempts to combine earth building technologies and advanced techniques to improve the energy efficiency of buildings.

The main objective of this study was the development and physical and mechanical characterization of CEBs stabilized with Portland cement and activated with phase change material, using a typical soil of the north region of Portugal. Having been evaluated the compression strength, deformation, water absorption, erosion and thermogravimetry of blocks with 25%, 50% and 75% direct incorporation of non-encapsulated PCM. The selection of a direct incorporation of PCM technique into CEBs was used and constitutes an economic alternative for obtaining an efficient and low-cost compressed earth block, due to the lower PCM cost acquisition and ease of adding PCM during the production process of CEB’s, compared to the encapsulation incorporation technique and encapsulated PCM. The

compressed earth blocks with PCM incorporation can be applied in the construction of exterior and interior walls.

MATERIALS AND COMPOSITIONS

Materials Characterization

The cement used in this study was a CEM I 42.5 R with density of 3150 kg/m^3. The PCM selected is non-encapsulated, composed by paraffin with temperature transition between 20-23°C, enthalpy of 200 kJ/kg, density in solid state of 760 kg/m^3 and in liquid state of 700 kg/m^3.

The soil used was collected in the north of Portugal (Barcelos), using mechanical equipment to extract the material to a depth greater than 1 meter. Its classification was made using conventional geotechnical characterization and regarding applicable standards.

Figure 1 and Table 1 show the particle size distribution (LNEC E 196, 1966). It can be concluded that the soil presents a continuous granulometry, presenting gravel, sand, silt and clay. However, this is a coarse soil mainly composed by sand with a fine fraction where the silt is predominant. Therefore, it can be classified as a silty sand.

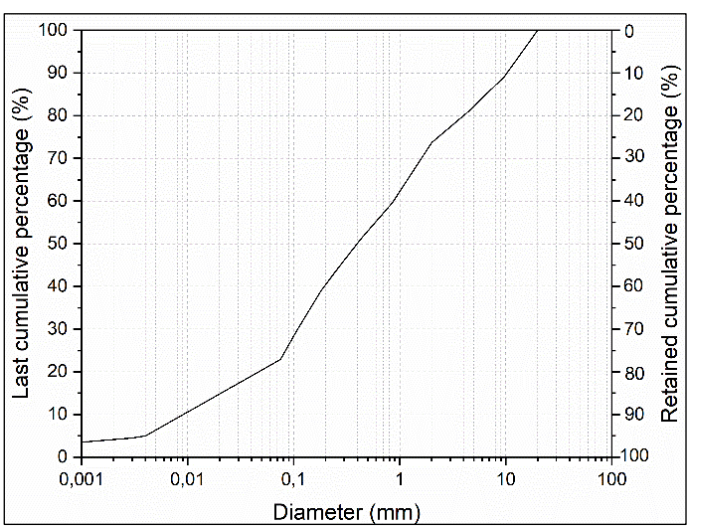

Figure 1. Particle Size Distribution Curve of Soil

Table 1. Soil Particle Size

	Dimensions (mm)	Quantity of Material (%)
Gravel	> 2	26.0
Sand	0.06 to 2	54.5
Silt	0.002 to 0.06	15.5
Clay	< 0.002	4.0

Several studies have been carried out, focusing on the influence of soil classification on the CEB's properties. Based on these studies, it was possible to verify that the more interesting results were obtained with the following soil fractions: sand and gravel 55-75%, silt 15-30%

and clay 10-30% (Bogas et al., 2019; Kasinikota & Tripura, 2021; Nagaraj, Rajesh & Sravan, 2016; Reddy & Latha, 2014; Walker, 1995). The selected soil has a fraction of sand and gravel of 80.5%, silt of 15.5% and 4% of clay. Based on these results, it can be concluded that the soil under analysis presents a fraction of sand and gravel slightly higher and a fraction of clay lower than intended. In this way, the soil was stabilized with Portland cement, in order to fill your clay requirement. This work also intends to evaluate the possibility of using a typical soil from the North region of Portugal, considering that one of the great advantages of earth construction is to use the raw material available on site. The density of the used soil is 2750 kg/m^3 (NP 83, 1995).

In addition, the liquid limit was determined by means of test procedures fully detailed in European standards (NP EN 143, 1969). The results of this test indicate a non-plastic soil, which is in line with expectations due to the predominance of silty fines (Table 1).

Compositions

Different compositions of compressed earth blocks have been developed (Table 2). It was developed a reference composition based in soil, water and 10% of cement in substitution of the soil (S10C). The HB 195-2002 standard recommends a minimum content of clay between 5% and 10% for stabilized and non-stabilized CEBs, respectively (Walker, 2002). Bearing in mind that the clay content obtained for the soil under analysis was 4% and is slightly below the recommended value for stabilized soils and significantly lower than the 10% recommended for non-stabilized soils, a content of 10% of cement was incorporated. The incorporation of cement had as objective the chemical stabilization of the soil and the increase of the mechanical behaviour and durability of the CEB's.

In order to evaluate the PCM influence, three compositions with PCM incorporation were developed, 25, 50 and 75% of PCM of the cement quantity (S10C25PCM, S10C50PCM and S10C75PCM). These PCM replace part of the water. The water content was fixed in 16.2% of the soil quantity, based in the empirical test of the ball.

Table 2. CEB's Compositions (kg/m^3)

Composition	Soil	Cement	PCM	Water
S10C	1743	174	0	311
S10C25PCM	1707	174	44	261
S10C50PCM	1671	174	87	212
S10C75PCM	1636	174	131	163

Specimen's Production

The CEBs manufacturing process was divided into four distinct phases: preparation of the raw materials, mixing of the materials, pressing and curing process. The preparation of the raw material consisted in drying the soil in a ventilated oven at 105ºC and obtaining the particles with dimensions lower than 4 mm. For the mixing of the materials, a mechanical mixer with a vertical axis was used, in order to obtain a homogeneous mixture. Subsequently, the pressing of the blocks was carried out with resource to a manual press (Figure 2), with a mold of 220x105x135 mm^3 (Figure 3). Finally, the curing process was made in a laboratory environment at a room temperature of around 20ºC and a relative humidity of 60% for 28 days.

Figure 2. Manual Press Used for CEB's Production

Figure 3. Produced Specimens with Dimensions of 220x105x135 mm^3

COMPRESSED EARTH BLOCKS CHARACTERIZATION

Water Absorption by Capillarity

Capillarity absorption is one of the main mechanisms used by water to penetrate in the blocks, in normal conditions of use. The water absorption by capillarity phenomena is caused by rain in a cyclical way or by the capillary rise of water from the foundation soil.

This test measures the water absorption capacity through the capillary vessels existing inside the CEBs, a phenomenon that occurs due to the pressure difference between the free water surface in contact with the block and the water surface inside the capillary vessels (Morel et al., 2007). The test was carried out considering the Portuguese National Laboratory of Civil Engineering specification (LNEC E393, 1993). For each CEB composition, 2 specimens were prepared. Initially, the specimens were placed in an oven at a temperature of 40±5°C for 14 days until they reached a constant mass. Subsequently, the CEB's were laterally protected and placed in contact with a 5 mm high water slide. The quantification of absorbed water was performed by conducting successive weightings in specimens. These weight measurements were accomplished according to a previously established weighting plan, beginning with the first contact of the specimens with water. The capillary water absorption coefficient was determined based on the behaviour of CEB's during the rapid capillary water absorption phase, between 5 minutes and 20 minutes, through a linear regression.

The water absorption behaviour by capillarity (Figure 4) is represented by a graph with two distinct phases: the first phase refers to the transport mechanism in porous materials, in which, the water penetration depends on the surface absorption rate in contact with the water. This section is defined until the existence of a significant change in the graph's development, where the inclination of the tangent line becomes to be less accentuated, reflecting the cessation of fast absorption and the initialization of slow absorption.

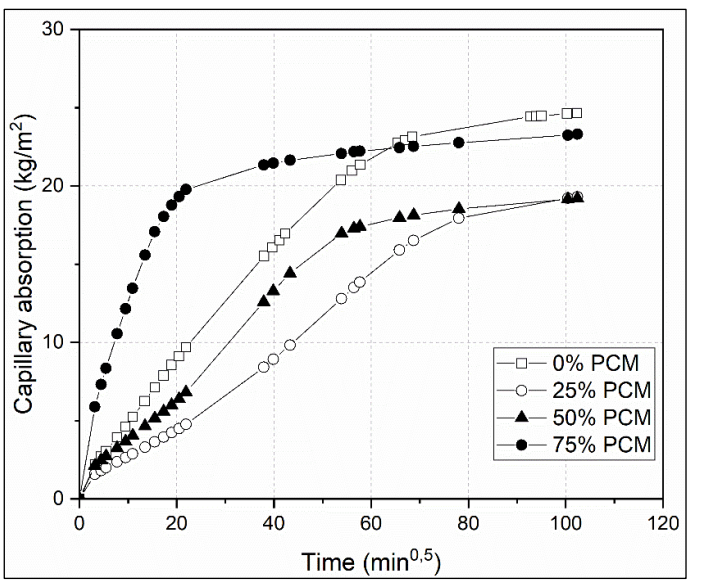

Figure 4. Water Absorption by Capillarity of the Compressed Earth Blocks

It was possible to observe that the capillary absorption was faster for the composition with the incorporation of 75% of PCM (S10C75PCM) and slower for the composition with 25% of PCM (S10C25PCM). The obtained results showed a variation coefficient of about 12%. It can also be verified that the composition without PCM incorporation (S10C) presents a faster water absorption compared to the composition with 25% and 50% of PCM incorporation, as well a higher global water absorption capacity, compared to all mortars doped with PCM. This behaviour can be justified by the fact that the compressed earth blocks without PCM incorporation possesses a higher quantity of free pores. On the other hand, compositions with higher levels of PCM have a higher capillary absorption coefficient (Figure 5), due to the decrease in the pore size of the block's microstructure, since the partial or total occupation of the CEBs pores by PCM and also by the fact that the PCM can coating the microstructure of soil-cement mixtures. This behaviour has already been studied and identified in other types of materials, such as cement mortars (Cunha et al., 2020a; 2020b).

According to Figure 5 it was possible to verify that the incorporation of 50% and 75% of PCM leads to an increase in the water capillarity absorption coefficient of about 46% and 236%, respectively. This behaviour can be justified by the decrease in the amount of water with the incorporation of higher PCM content (Table 2). The presence of a lower water content prejudice the cement hydration process, due to the greater difficulty in the water contact with the cement particles, which increase the porosity.

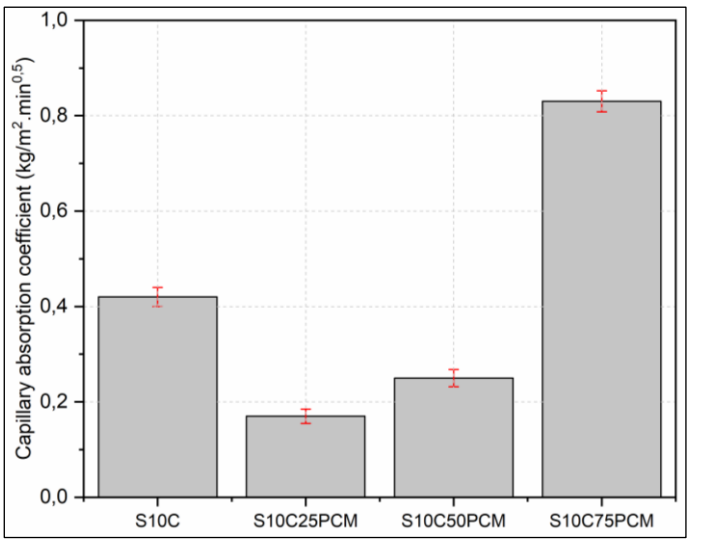

Figure 5. Capillary Absorption Coefficient of the Compressed Earth Blocks

Water Absorption by Immersion

Another form of water absorption in the CEBs derives from its immersion, this has a direct influence on its durability. This test allows the quantification of the volume of accessible voids and is carried out based in the Portuguese specification (LNEC E394, 1993). For each composition, 2 specimens were prepared. Initially, the specimens were dried in oven until the constant mass. Subsequently, they were saturated with resource to a container with water at a temperature of 20±3°C. Finally, after saturation, the hydrostatic mass was determined. The obtained results allowed us to determine the water absorption by immersion of the different compositions. This was determined according to the Equation 1:

$$W = \frac{(M_1 - M_3)}{(M_1 - M_2)} \times 100 \quad (1)$$

Where:

W - Water absorption by immersion (%);
M_1 - Mass of saturated specimen (g);
M_2 - Hydrostatic mass of saturated specimen (g);
M_3 - Mass of dried specimen (g).

According to Figure 6, it can be verified that the compositions doped with PCM has a capacity of water absorption by immersion lower than the reference composition (S10C). The incorporation of PCM resulted in a decrease in water absorption by immersion of more than 24%. This behaviour can be justified by the presence of PCM in the microstructure of the soil-cement mixtures, since the PCM will occupy total or partially the mixture pores and also due to the hydrophobic nature of the PCM. This behaviour is in accordance with the decrease in porosity observed for cementitious materials with incorporation of non-encapsulated PCM (Cunha et al., 2020a; 2020b). On the other hand, it is important to note that for compositions with PCM incorporation, it was verified an increase in the water absorption by immersion.

This behaviour is due to the decrease in the amount of water with the increase of the PCM incorporation (Table 2), since a smaller amount of water affects the hydration of the cement, due to the greater difficulty in the contact of the water with the cement particles, which results in a higher porosity.

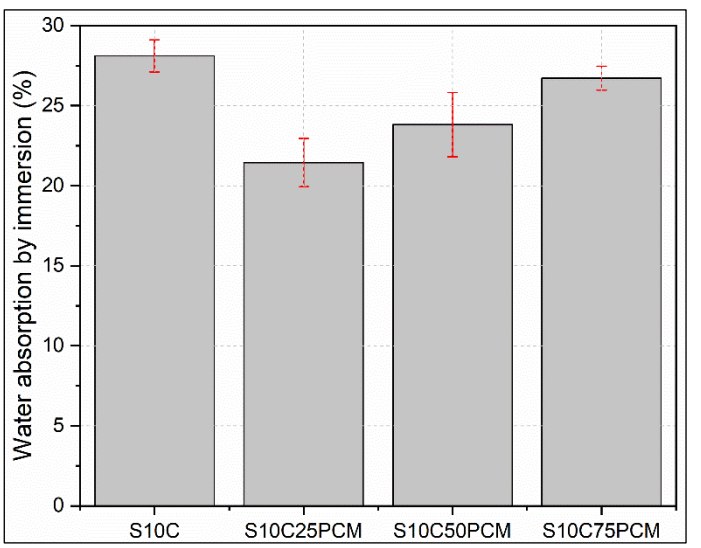

Figure 6. Water Absorption by Immersion of the Compressed Earth Blocks

Compressive Strength

To analyse the mechanical strength of the compressed earth blocks, compressive strength tests have been performed, based in the recommendations stipulated in the European standard (NP EN 772-1, 2002). Compressive tests were realized through the application of a load on the specimen, with resource to two metallic piece rigid enough to make the vertical load uniform. The tests were performed with load control at a speed of 500 N/s. For each composition, 3 specimens were prepared.

Figure 7 shows the compressive strength of the compressed earth blocks. It was possible to observe that the incorporation of 25% PCM resulted in an increase in compressive strength of about 10%. However, the incorporation of higher levels of PCM, 50% and 75% of PCM, has been shown to contribute to a decrease in compressive strength of about 11% and 51%, respectively.

It was possible to verify that the incorporation of PCM in high quantities (S10C50PCM and S10C75 PCM) is unfavourable for the compressive strength, because in these mixtures there is a lower amount of water, since the PCM is added liquid and contributes to the workability of the mixture without contributing to the cement hydration. On the other hand, it was verified a higher porosity on these mixtures (Figure 6). In the opposite direction, for mixtures with low percentages of PCM (S10C25PCM), there is a slight increase in compressive strength, which can be justified by the fact that the amount of water present is sufficient for the hydration of the cement. The decrease in the compressive strength of cementitious mortars with direct PCM incorporation has also been identified (Cunha et al., 2020a).

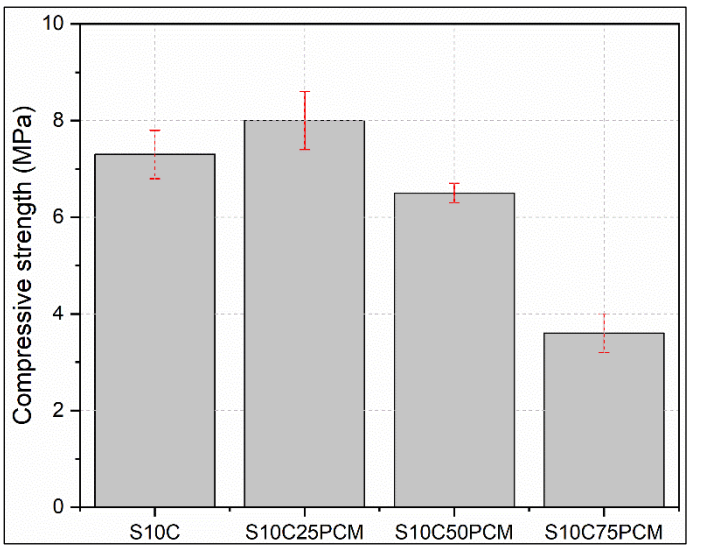

Figure 7. Compressive Strength of Compressed Earth Blocks

The compressive strength of CEBs varies according to the type of soil and the use of binders or adjuvants. Currently, there is no minimum regulated value for this characteristic. However, several authors present several indicative values that CEBs should meet (Table 3) (ABNT NBR 8491, 2012; DIN 18945, 2018; NTC ISO TS 17234, 2003; UNE 41410, 2008). Thus, it was possible to conclude that all the mixtures presented in this study lead to a compression strength higher than the minimum strength standards set out in several countries. Therefore, even with a decrease in compressive strength, the incorporation of PCM does not preclude the possibility of utilization of these CEBs. On the other hand, the compressive strength presented by CEBs doped with PCM is higher when compared to the compression strength of conventional bricks whose values are comprised between 1.5 to 1.9 MPa (Preceram, 2022).

Table 3. Minimum Compressive Strength (MPa)

Author	Compressive Strength
NTC-ISO-TS 17234	2.0
NBR 8491	1.7
UNE 41410	1.3
DIN 18945	2.5

Deformation

For determination of the CEB's deformation, the LVDT's recorded the deformation values of the block as the load cell applied the force of 500 N/s. For each composition, 3 specimens were prepared. Figure 8 shows the test setup used.

Figure 9 shows the stress-strain curves of the different tested compositions. The obtained results showed a variation coefficient of about 15%.

Figure 8. Setup Test for Determination of Deformation of Compressed Earth Blocks

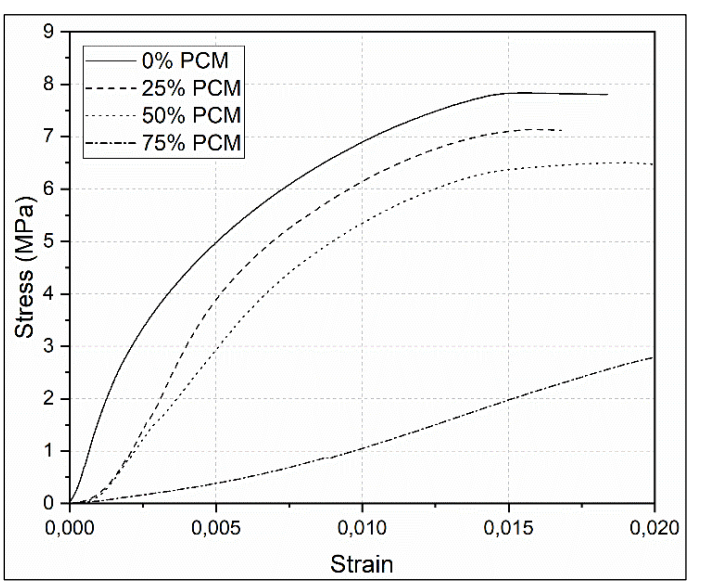

Figure 9. Stress-Strain Curves of Compressed Earth Blocks

Figure 10 presents the modulus of elasticity of the compressed earth blocks. The incorporation of 25% PCM did not cause a significant change in the modulus of elasticity. However, the incorporation of contents of 50% and 75% of PCM resulted in a decrease of 41% and 72%, respectively. This behaviour is related to the fact that the PCM has a lower modulus of elasticity compared to the other mixture constituents, due to the fact that it is a polymeric material, and the rest of the constituents are minerals. The existence of a lower modulus of elasticity indicates a greater ductility of the material, which becomes more advantageous from the point of view of building behaviour using this constructive technique. On the other hand, it was possible to verify a correlation between the compressive strength and the modulus of elasticity. The CEBs with lower compressive strength showed a lower modulus of elasticity.

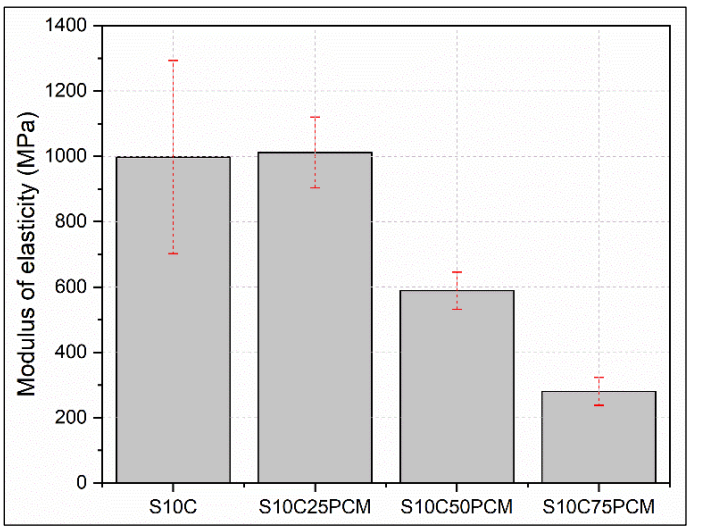

Figure 10. Modulus of Elasticity of The Compressed Earth Blocks

Rain Erosion Test

The test of erosion with the rain consists in evaluate the behaviour of CEBs in relation to the degradation caused by water falling on their faces, determining their degradation.

For the execution of the test, the methodology proposed by Rezende, Eires, Camões and Jesus (2016) were followed, which evaluates the rain erosion that occurred in exterior masonry during 50 years of exposure, in a Portuguese climatic condition. For each composition, 2 specimens were prepared.

Initially the specimens were placed in an oven at a temperature of 105±5ºC until the constant mass. Subsequently, the CEBs were placed under the rain simulator's metallic mesh (Figure 11), and the rain fall simulation was carried out by exposing the blocks for 120 minutes to a conical water jet with a flow rate of 14.26 l/min at an output pressure of 45 kPa. After the test, the CEBs were placed on a non-absorbent surface for 30 minutes and their wet mass was recorded. Finally, the CEBs were placed again in the oven at a temperature of 105 ± 5ºC until they reach the dry constant mass. This process is repeated during three test cycles.

Figure 11. Rain Erosion Test Procedure

To determine degradation and rainwater absorption, the Equations 2 and 3 were used.

$$LM = \frac{m_i - m_{df}}{m_i} \times 100 \quad (2)$$

Where:

LM – Loss mass by degradation of rain action (%)
m_i - Dry mass before test (g)
m_{df} - Dry mass after test (g)

$$W_a = \frac{m_h - m_{df}}{m_h} \times 100 \quad (3)$$

Where:

W_a - Rainwater absorption (%)
m_h - Wet mass after test (g)
m_{df} - Dry mass after test (g)

According to Table 4 it was possible to observe an increase in the loss mass by degradation of rain action with the incorporation of PCM. The incorporation of 25% of PCM leads to an increase of about 150%. This increase is more expressive with the addition of higher PCM contents. This behaviour can be associated with the fact of the PCM incorporation decrease the compressive strength of CEBs (Figure 7) and due to its increase in porosity, indicated by the increase in water absorption by immersion (Figure 6).

Table 4. Wear by Erosion and Rainwater Absorption (%)

Composition	Loss Mass by Degradation of Rain Action (%)	Rainwater Absorption (%)
S10C	0.044	11.86
S10C25PCM	0.110	4.92
S10C50PCM	0.142	5.77
S10C75PCM	0.228	10.40

Regarding to the rainwater by absorption (Table 4) it was possible to observe a decrease of about 59% with the incorporation of 25% of PCM. However, the incorporation of higher PCM levels leads to a decrease in the absorption of rainwater less significative. Once again, this behaviour is associated with the PCM presence in the mixture pores and with their hydrophobic nature.

Taking into account the compressive strength of the different developed CEBs, it was possible to verify that a lower compressive strength led to a higher loss mass by degradation and rainwater absorption.

Compressive Strength After Rain Erosion Tests

This test had as main objective to evaluate the mechanical behaviour of CEBs after their exposure to an aggressive environment. The tests were performed based in the recommendations stipulated in the European standard (NP EN 772-1, 2002).

According to Figure 12, it can be concluded that, contrary to expected, the compressive strength after the rain erosion test increased more than 17%, comparatively with the compressive strength before the rain erosion test. This increase is due to the fact that the CEBs were placed in an oven at 105ºC, which accelerated the cement hydration process, resulting in an increase in its mechanical strengths.

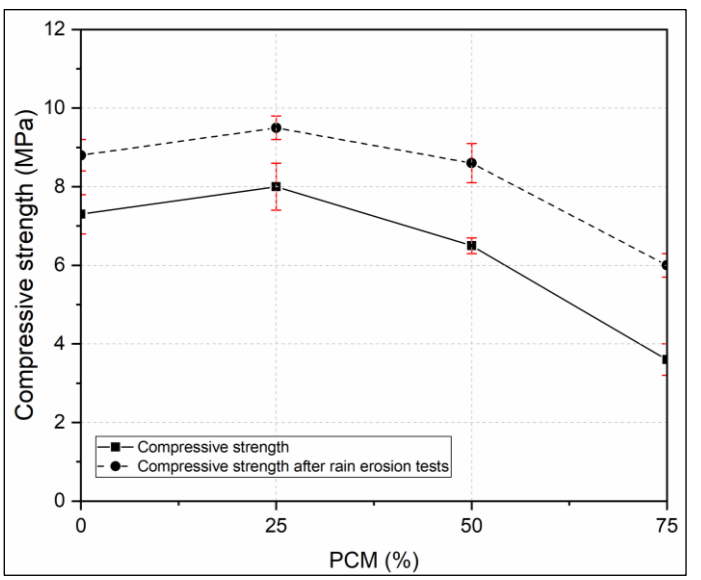

Figure 12. Compressive Strength Before and After Rain Erosion Tests of The Compressed Earth Blocks

It was also possible to verify that the incorporation of higher levels of PCM originated a greater increase in the compressive strength after the CEBs submission to the erosion tests to rainwater. This behaviour is related to the increase of water absorption capacity with the presence of a higher PCM content (Figure 5, Figure 6 and Table 4). Considering that the incorporation of PCM in the liquid state resulted in a decrease in the amount of water present in the mixtures (Table 3) in order to maintain its workability, it can be concluded that the absorbed rainwater also contributes to the hydration of cement that has not yet been chemically combined with water, also increasing the development of its compressive strength.

Thermogravimetry Tests

Thermogravimetry tests measure the variation in sample mass (loss) as a function of the temperature variation imposed on the analysed material. The test was performed using a specific equipment from TROXLER model 4155B. The results of the thermogravimetry tests consists of a thermal curve that represents the mass variation of samples as a function of temperature, which records the energetic phenomena developed during the temperature variation process.

Figure 13 shows the results obtained. It can be concluded that the reference composition shows the higher mass loss, which can be justified in part by the presence of a higher water content which evaporating during the test.

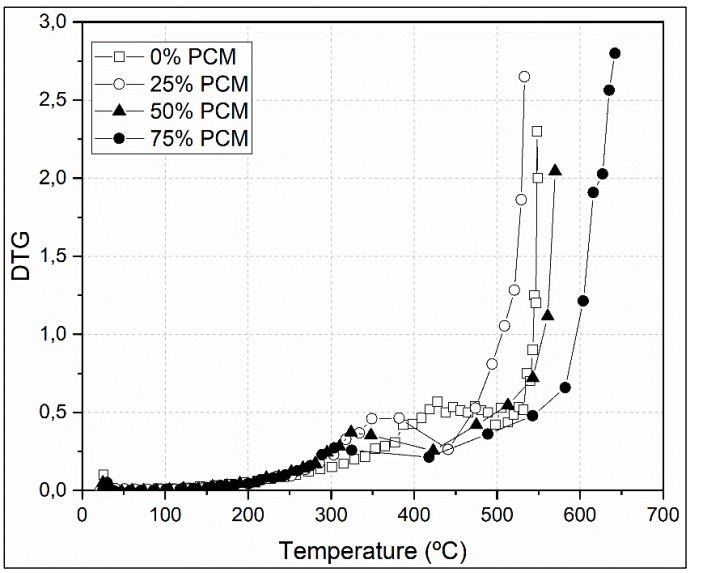

Figure 13. Thermogravimetry Tests of The Compressed Earth Blocks

It was also possible to observe in the mortars doped with PCM, the existence of inflection points, which were identified between 300ºC and 400ºC. It was expected the existence of a peak point at a temperature approximately of 200ºC related to the flash point of the PCM, however it was not possible observe this inflection point due to the reduce PCM content present in the samples (Rubitherm, 2022). The peak points between 300ºC and 400ºC are related with the dihydroxylation of calcium hydroxide ($Ca(OH)_2$) into calcium oxide and water ($CaO+H_2O$) (Anjos et al., 2012; Cunha et al., 2020a).

It is important to note that compositions with PCM incorporation have less pronounced curves. This behaviour is related to the presence of a lower water content in the compositions added with PCM, which causes a delay in the cement hydration process and, consequently, lower quantity of calcium hydroxide formation.

CONCLUSION

This study evaluated the physical and mechanical properties of compressed earth blocks with incorporation of non-encapsulated phase change materials.

Based on the obtained results, it can be concluded that the addition of phase change materials leads to some changes in the water absorption by capillarity and immersion, compressive strength, modulus of elasticity, rain erosion tests and thermogravimetry.

The incorporation of non-encapsulated PCM causes a:

1. Decrease in water absorption, due to the partial or total occupation of the mortar pores by the PCM presence in the compressed earth blocks;
2. Decrease in the compressive strength and the modulus of elasticity, due to a lower water content, which can negatively affect the cement hydration;

3. Increase in the wear erosion, due to the decrease of the compressed earth blocks compressive strength and their increase in the porosity;
4. Increase the compressive strength after the rain erosion test comparatively with the compressive strength before the rain erosion test, due to the accelerated cement hydration process in the oven and to the water rain absorption;
5. Lower formation of calcium hydroxide, revealed in the thermogravimetry tests.

In summary, it can be concluded that the compressed earth blocks with incorporation of non-encapsulated PCM showed a compressive strength higher than the minimum strength established in several countries. Thus, it is possible to conclude that the presence of PCM, even negatively affecting the compressive strength of CEBs, its practical application can be carried out safely. The composition with 25% PCM incorporation (S10C25PCM) is the one that leads to a more satisfactory behaviour from the point of view of water absorption, compressive strength and erosion wear.

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A STUDY ON THE IMPACT OF AN URBAN METRO RAIL PROJECT ON REAL ESTATE RENTAL VALUES

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Abstract
Development of an urban infrastructure project can have wide-ranging impacts viz improved quality of life, increase in the industrial activities, creation of employment to name a few. In addition to this, one of the significant aspects that get impacted is the rental values of properties located around the vicinity of the project. The present study has conducted a survey of the tenants and property owners to assess the rental values of residential and commercial properties in the vicinity of the metro project. To assess the impact of the project on the rental values, a survey was conducted within two zones – one zone within a 500 m radius of the metro rail station and the second one with properties located at a radius more than 500 m from the metro rail station. To specifically identify the impact of the metro rail project on rental values, the responses were analysed using the Hedonic regression method in SPSS. Results of the study indicate that the rental values of the properties in the vicinity of the metro project are positively impacted to the extent of 14.3 % in the case of residential buildings and 16.2 % in case of commercial buildings located in close proximity (<500 m) to the metro station than the properties located far away (>500 m) from the metro station. Results revealed that while the metro project has improved the commute time of the residents, it has negatively influenced the air quality, noise levels, and quality of life. The results of the study can help builders, investors, real estate consultants, and owners/tenants to gauge and make a fair assessment of the rental values and equip them for making informed decisions.

Keywords: *Real estate; rental value; construction; infrastructure; hedonic regression*.

INTRODUCTION

In India, Delhi Metro Rail Corporation began its operation on 24 December 2002, and it has a marked record of increase in ridership day by day. This successful model gave confidence to other state governments to implement metro rail projects in their respective states. To cater to public transport needs and to mitigate the ever-growing road traffic, the State government of Telangana, India decided to implement the metro rail project in Hyderabad, India. Hyderabad metro rail is a mass rapid transit project promoted by the state government and the concessionaire is L&T.

The role of transportation has long been a central component in the evolution of urban development because it increases access to marketplaces, employment opportunities, city centres, recreational facility and other central points which directly have an impact on property values.

The real estate industry, providing housing to people is considered a key contributor to the growth of an economy whether it is of a nation or any region. Real estate development is not only about housing projects but also the development of all types of commercial spaces (Mohammad, Graham and Melo, 2015).

The value of the real estate property is a phenomenon that is complicated and multi-faceted, and can be attributed to several variables/factors, such as the strength of the local economy, demographics of the market area, ease and convenience of access to critical amenities, and property characteristics. Having the ease and convenience of access to public transportation services can be considered as a valued amenity. Thus, it is generally perceived that when public transport systems are introduced into an urban region, the system usually creates transit-oriented development and the general tendency is to witness uplifts in the value of the properties. The properties located in close proximity to metro stations enjoy many significant benefits such as enhanced access to employment opportunities, access to recreational activities and retail outlets, convenient options of mobility, and reduced transportation costs. These relative advantages are expected to reflect positively on the values of properties. Therefore, intensive development opportunities near metro stations can be stimulated by the uplift in land values (Forouhar, 2016).

The objective of the research study is to assess the impact of Hyderabad metro rail on the rental values of the properties. The study mainly focuses on comparing the rental values of the properties located at a walkable distance from the Metro Railway stations with that of the properties located away from the metro stations.

The findings from the research will benefit home buyers, businesses for their commercial establishments, real estate developers or builders to propose new projects or to fix the new rates for the existing projects and public administrators, urban planners to propose new developmental activities for the welfare of the community. The results shall also help in forecasting the real estate values in the areas where new infrastructure projects are proposed.

LITERATURE REVIEW

To understand the factors, methods, and approaches for investigating the impact of urban transportation projects on rental values, it was necessary to review the literature. A detailed literature review has been done. From the literature review the research gaps are identified which forms the foundation for this study.

The process of literature review started by searching through the research databases. A keyword-based search strategy was deployed. Keywords such as rental values, the impact of the metro, social life, etc., were the keywords used for the search of the relevant articles. The title and the abstract of the initial list of articles obtained were reviewed and only articles found relevant for this study were selected. A detailed review of current and past studies is also presented to assess the relationship between Metro Railway Project and property value. Table 1 summarizes the relevant literature with studies across the world, methodologies adopted for the investigation, and the conclusions of these studies.

The following section provides an overview of select literature studies on railway projects and their effect on residential and commercial properties based on the different metro cities of the world.

A study conducted by (Gatzlaff and Smith, 1993) investigated the impact of the Miami metro on the selling value of residential properties located near the metro stations. Repeat sales value and hedonic regression method were adopted to assess the impact of Miami metro

on residential sale values. The study concluded that the sale values were weakly impacted by the announcement of a new metro system.

A study conducted by (Clower and Weinstein, 2002) investigated the impact of the presence of a Light Rail Transit (LRT) system on the property valuations in the immediate proximity of the Dallas (Texas) rapid transit LRT stations. The county appraisal district data were used for the study. The study indicated that the valuations of office properties located in the vicinity of stations increased by 24.7% as compared to 11.5% in the other regions.

The impacts of an urban rail LRT system on values of residential property in Houston were investigated in a study conducted by (Pan, 2013)**.** The study used the 2007 InfoUSA household data to analyse the impacts of the LRT system on the property values. A multi-regression model was used for the study and the study found that there was a significant positive effect on the values of residential properties. The study also found that immediate location within a quarter-mile of the stations and bus stops had negative impacts on the residential property values.

In an investigation (Armstrong and Rodríguez, 2006) conducted to examine the benefits of rail service in Eastern Massachusetts, adopted spatial hedonic price functions on the data of 1860 single-family residential values from four municipalities with rail service and three without community rail service, found out that commuter rail stations exhibit values that are between 9.6% and 10.1% higher than properties in municipalities without a commuter rail station.

From the sections of the literature review, and the summary in Table 1, it can be seen that most of the studies have used largely hedonic price models to assess the impact of rail transit systems on property values. Because Hedonic models offer to introduce more rigorous controls, for ascribing benefits associated with factors like proximity to transportation facilities, these are widely considered (Cervero and Duncan, 2001). Multiple regression techniques are applied to apportion real estate values to various explanatory variables, giving due consideration to other marginally contributing factors such as accessibility, land-use type, and neighbourhood quality to sales values. Some of the studies (Lin and Hwang, 2004) have adopted multivariate regression to calibrate fuzzy hedonic price models.

The studies mostly have selected the selling value of the properties as the dependent variable and a variety of combinations of variables when choosing the independent variables for the investigation. Various independent variables such as length of stay & occupation (Babatunde, Ojetunde and Kemiki, 2016), accessibility, location (Hess and Almeida, 2007), and neighbourhood attributes (Cervero and Duncan, 2001), (Cervero, 2010) and a combination of these have been chosen in their studies.

From the review of literature, it was found that most of the studies are conducted in the developed economies that too largely in the USA, apart from Canada, Australia, Netherlands, and Chile. There are very few studies in the developing economies that have investigated this aspect. In addition, except for the study by (Babatunde, Ojetunde and Kemiki, 2016) all of the studies have focused on the relationship of selling values of the properties with that of the proximity to that of an urban rail project and have not explored the aspect of property rental values and its movement with that of the development of an urban rail project. Further,

from the studies, there are very limited studies in the Asian region and the Indian subcontinent region. With the above gaps, the present study intends to investigate the impact of an urban metro rail system on the rental values of the properties located within close proximity to the stations in the city of Hyderabad, India.

Table 1. Research Studies on Railway Projects and Their Impact on Real Estate Properties

S No	Research Study	Country/ Location of study	Type of rail system	Dependent variable	Independent Variables	Research method	Study Outcomes / Conclusions
1	(Dziauddin, Powe and Alvanides, 2015)	Malaysia	Light Rail Transit System	Residential property values	Size of property, location attributes	Geographically Weighted Regression (GWR) method	Positive impact in some areas and negative in other areas
2	(Hewitt and Hewitt, 2012)	Canada	Urban Rail Transit	Selling Price of Property	Area, No. of bedrooms, No. of bathrooms, Age of the property	Spatial Regression and mapping	Significant statistical relationship exists and that the property values tend to decrease with increasing distance from the train stations
3	(Cervero and Duncan, 2001) and (Cervero, 2010)	USA	Light and Commuter Rail Transit	Commercial Land Values	Commercial and residential, property characteristics, proximity, neighbourhood characteristic	Hedonic Price Model, GIS Data for mapping the land parcel	23% capitalization impact for a commercial parcel near LRT stop and more than 120% for commercial land in business district
4	(Mohammad, Graham and Melo, 2015)	Dubai	Metro Rail	Sale values of residential and commercial properties	Proximity to Train Station, nearest School, hospital population density, employment density	Hedonic Price Models	Value of dwellings and commercial properties is largest within 701 to 900 meters of a metro station and is about 13 percent and 76 percent, respectively
5	(Yan, Delmelle and Duncan, 2012)	USA	Light Rail Transit System	Single-family housing values	Proximity, building characteristics, stage of metro development	Hedonic Price Model	Before metro rail development negative impact and positive impact during operational phase
6	(Ko and Cao, 2013)	USA	Light Rail Transit System	Selling Price of Property before and after metro project	Structural characteristics, Transportation network accessibility, Socio economic parameters	Hedonic Price Models	Decrease in the prices of the property away from the stations
7	(Chen, Rufolo and Dueker, 1998)	USA	Light Rail Transit System	Single family home values	Physical attributes, Neighbourhood attributes, locational attributes, and fiscal parameters	Hedonic Model with GIS application	Positive effect in terms of accessibility and negative effect in terms of nuisance
8	(Bowes and Ihlanfeldt, 2001)	Dubai	Metro Rail	Sale values of residential and commercial properties	Proximity to Train Station, physical attributes of building, location characteristics	Hedonic Price Models	The price is impacted by proximity to station, neighbourhood crime and retail activity

S No	Research Study	Country/ Location of study	Type of rail system	Dependent variable	Independent Variables	Research method	Study Outcomes / Conclusions
9	(Forouhar, 2016)	Tehran	Metro Rail System	Price before and after opening of stations	Sale Transactions of average or normal houses	Hedonic and Difference-in-Differences method	Negative effect of the metro stations on the sales value of the properties
10	(Damm *et al.*, 2015)	USA	Heavy Rail Transit System	Single-family, multi-family & retail properties	Proximity, building characteristics, no. of years until station completion, annual income	Hedonic Price Model	Real estate property shifts occur in the proximity of the station
11	(Agostini and Palmucci, 2008)	Chile	Metro Rail Transit System	Selling Price of Property before and after metro project	Structural characteristics, Transportation network accessibility, Socio economic parameters	Hedonic Price Models	Decrease in the prices of the property away from the stations
12	(Debrezion, Pels and Rietveld, 2011)	Netherlands	Light Rail Transit System	Transaction price of houses	House features, accessibility features, environmental features	Hedonic price model	Houses close to rail stations are at least 25% more expensive than houses at a distance of more than 15 km
13	(Kim and Lahr, 2014)	USA	Light Rail Transit System	Sale values of residential properties	Network distance, aerial distance, median household income	Repeat sales data	Properties around the stations witness higher rates of appreciation
14	(Ge, Macdonald and Ghosh, 2012)	Australia	Light Rail System	Dwelling prices	House characteristics, proximity, stage of construction	Spatial and GIS analysis	Appreciation more before commencement of construction and after opening of service

RESEARCH METHODOLOGY

The present research work was carried out in the city of Hyderabad, Telangana State, India. Hyderabad Metro Rail system was one of the first successful projects in India that were developed through the Public-Private Partnership (PPP) model. The project is intended to connect three high-density traffic corridors as shown in Figure 1 – Miyapur to LB Nagar corridor also called the red line, a total track length of 29 km with 27 stations, JBS to Falaknuma corridor also called as the green line a total track length of 15 km with 15 stations and Nagole to Raidurg corridor also called as the blue line with a total track length of 28 km with 24 stations. Among these, the blue line and red line are the ones fully commissioned and the busiest corridors. The Hyderabad metro line network map is analysed initially. The metro ridership data is collected from secondary sources and Google maps of the metro stations are collected to analyse the intensity of the real estate establishments located in close proximity to the metro stations. Based on this data, the metro lines and the metro stations are identified for data collection. Metro stations viz., Ameerpet, Kukatpally, Begumpet from the blue line and LB Nagar, Hitec City, and Lakdikapul from the red line were selected for this study.

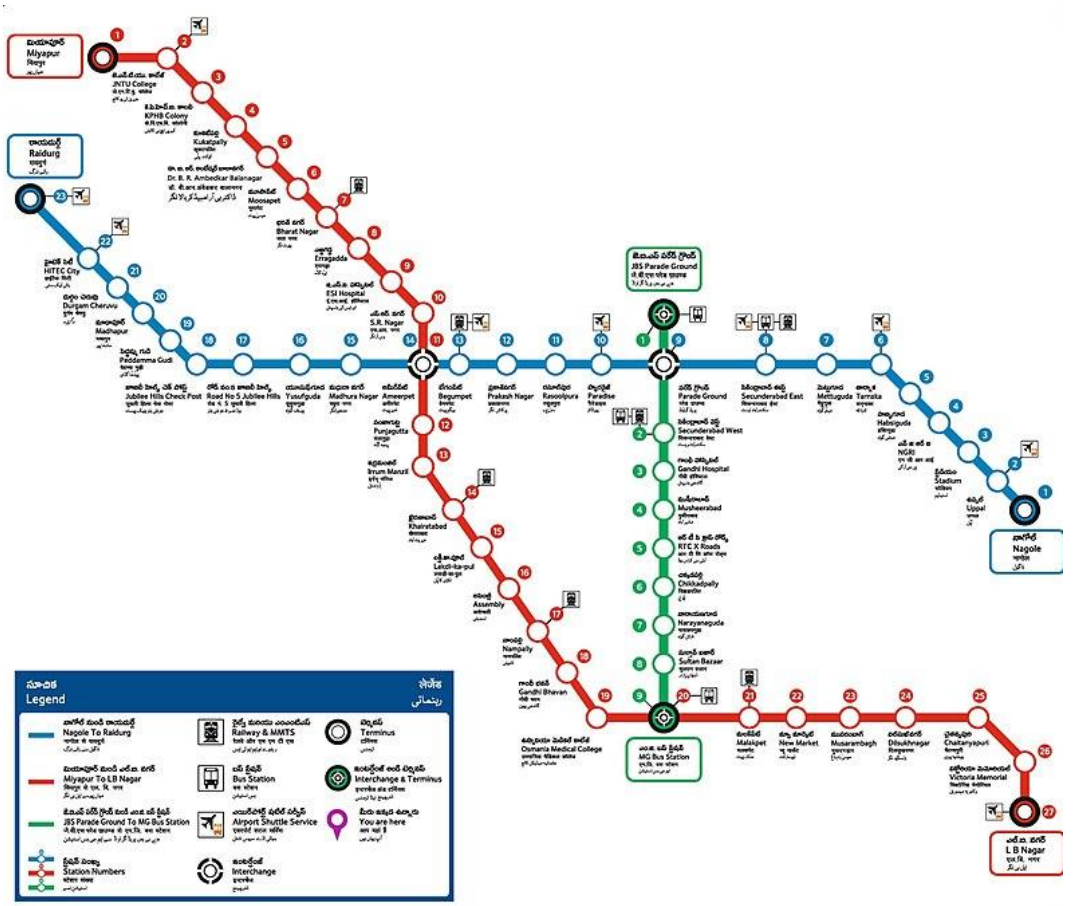

Figure 1. Hyderabad Metro Map

The research work intended to investigate two significant aspects about the impact of metro projects as mentioned previously and outlined below;

- To investigate the impact of metro projects on the rental values of properties located in close proximity (< 500 m) distance from the stations
- To investigate the socio-economic impacts of the metro project development on the tenants in the proximity of metro rail stations.

The flow of the research work and the methodology adopted to progress towards the planned objectives are presented in Figure 2.

Identification of Attributes & Statistical Analysis Methods

The thorough literature review carried out helped identify the gaps of earlier studies which are already sufficiently explained in the earlier sections of the paper. In addition to this, the literature review also helped identify the methods adopted by earlier studies and also the attributes, variables to be selected for the study. The independent variables affecting the rental value of the real estate properties are identified from the literature and the ranking of the variables is carried out by identifying the most commonly chosen to set of factors by the

earlier studies. Based on the nature of the project and the prevailing conditions (keeping in mind the fact that non-essential activities were not allowed during the time of pandemic due to government regulations), local character of the region and the ranking list, top five attributes/independent variables were considered for inclusion in this study and the questionnaire.

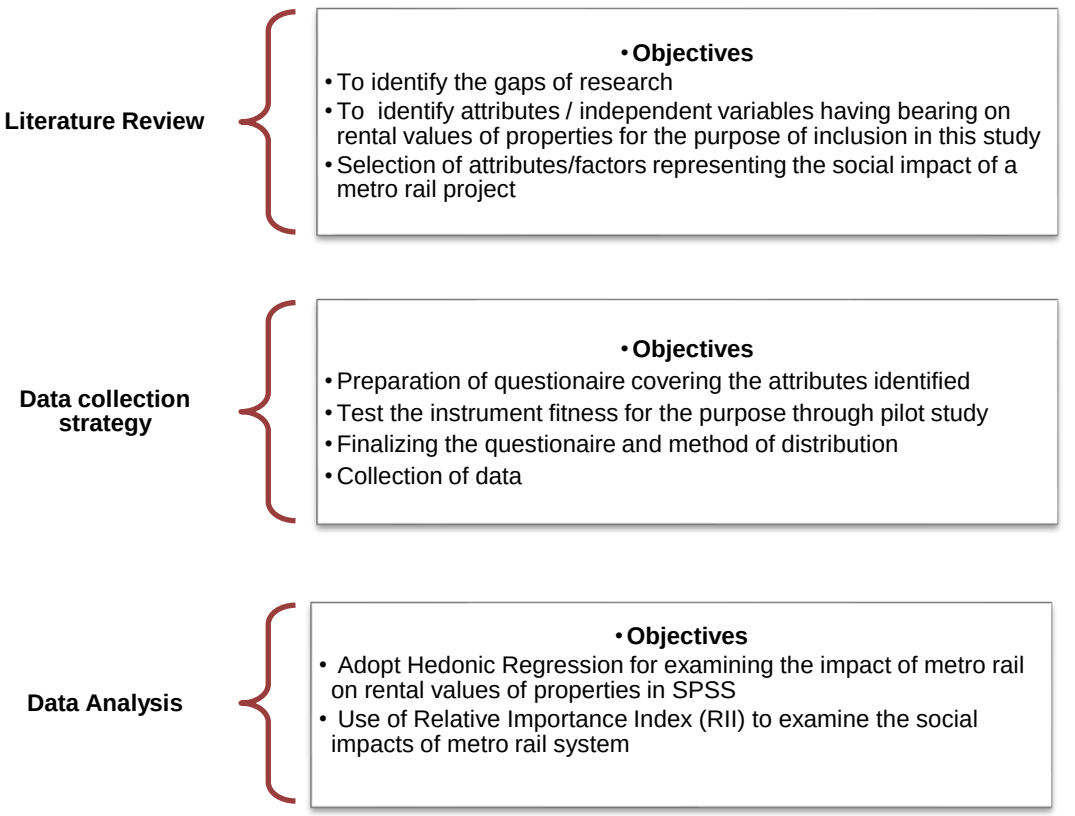

Figure 2. Research Methodology

Questionnaire Survey

For this research, a questionnaire survey method has been adopted to find the impact of metro rail on Hyderabad real estate. A notable number of questionnaires were referred to from the literature for preparation. The questionnaire was structured into four sections namely personal information, physical location, neighbourhood & environmental attributes. The personal information section sought some basic information such as name, gender, age group, profession, and distance of the tenant's residence to the metro station. The questions were structured in a very simple way such that they could be easily understood by the respondents. Physical and location attributes of the questionnaire included open-ended, multiple-choice, and dichotomous questions and the neighbourhood & environmental attributes consisted of questions to be rated on a 5-point Likert scale. The questionnaire survey was conducted on homeowners, real estate developers, tenants or lessees, brokerage firms, and owner's association of residential real estate properties in the vicinity of the stations mentioned earlier. Table 2 presents the attributes/variables selected for inclusion in the questionnaire.

Table 2. Attributes Included in The Questionnaire

S No	Physical Attributes	Location Attributes	Neighbourhood & Environmental Attributes
1	Type of property	Distance to nearest metro station	Employment opportunity
2	Location	Metro station name	Commute time
3	Rental Value	Metro line	Household income
4	Home size/ Floor space	Distance to nearest Bus Facility	Ambient Air quality
5	Age of the building	Distance to nearest School	Ambient Noise level
6	No of bathrooms	Distance to nearest Hospital	Quality of life
7	No of bedrooms	Distance to nearest shopping area	
8	No of car parks		

Prior to floating the questionnaire for data collection, to ensure the questionnaire fits the purpose and objectives of the study and that questionnaire can be understood and responded to without much difficulty, the questionnaire was subjected to a pilot study. Three academicians with over 15 years of experience in the subject area and two industry experts from real estate organizations were asked for their opinion. The experts sought a few minor changes in the sections and framing of questions which was incorporated in the final questionnaire.

Data Collection and Collation

The Hyderabad metro line network map is analysed initially. The metro ridership data is collected from secondary sources and Google maps of the metro stations are collected to analyse the intensity of the real estate establishments located in close proximity to the metro stations. Based on this data, the metro lines and the metro stations are identified for data collection. The questionnaire was given to tenants and owners of residential and commercial properties located in the proximity of the Ameerpet, Kukatpally, Begumpet, LB Nagar, Hitec city, and Lakdikapul metro stations. Initially, the data is segregated by metro lines and the type of residential properties. Table 3 presents the summary of the collected responses.

Table 3. Summary of Responses

Response Summary							
Total Number of Responses				120			
Valid responses analysed				84			
Valid response Rate				83%			
Residential Properties				81			
Commercial Properties				19			
METRO BLUE LINE				**METRO RED LINE**			
Residential		**Commercial**		**Residential**		**Commercial**	
Stations	**No of responses**	**Stations**	**No of responses**	**Stations**	**No of responses**	**Stations**	**No of responses**
Ameerpet	13	Ameerpet	9	Kukatpally	13	Kukatpally	10
Begumpet	12			LB Nagar	11		
Hitec City	11			Lakdikapul	5		
Total	**36**	**Total**	**9**	**Total**	**29**	**Total**	**10**

RESULTS & DISCUSSION

Impact of Metro Rail Stations on Rental Values of Properties

The data obtained from the questionnaire responses were required to be analysed. As already indicated, the rental values of the properties are dependent on several independent variables and the proximity to metro stations cannot be alone considered as a factor. To assess the impact, independent variables viz., proximity to metro stations, age of the property, carpet area of the property, no. of car parking space, proximity to bus stations, shopping malls, hospital/healthcare facility, schools, etc., were considered. Valid complete responses were fed into and analysed by SPSS Version 23. The dependent variable is chosen as the logarithm of rental values of the properties as adopted by earlier studies (Pan, 2013), (Agostini and Palmucci, 2008) since it allows the estimated value to vary proportionately with different components of independent variables (Yan, Delmelle and Duncan, 2012). The standardized SPSS output summary for residential properties (including blue line and metro line) is presented in Table 4 & Figure 3.

Table 4. SPSS Output for Residential Buildings

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.883[a]	.780	.744	.10203	1.467

a. Predictors: (Constant), Shopping, School, Bus, Metro, No. of car parks, Age of the Building, Hospital, Carpet Area, No of bedrooms

b. Dependent Variable: Rental Value

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	3.720	.071		52.583	.000		
	Carpet Area	.000	.000	.665	5.585	.000	.282	3.544
	Age of the Building	-.025	.021	-.088	-1.207	.233	.752	1.331
	No of bedrooms	.022	.036	.077	.613	.542	.254	3.932
	No of car parks	.076	.022	.267	3.449	.001	.665	1.504
	Metro	.057	.027	.143	2.114	.039	.871	1.149
	Bus	.041	.029	.099	1.396	.168	.796	1.256
	School	.042	.032	.104	1.317	.193	.645	1.551
	Hospital	-.030	.031	-.074	-.969	.337	.678	1.474
	Shopping	.042	.033	.098	1.282	.205	.681	1.469

a. Dependent Variable: Rental Value

The results presented in Table 4 provide the coefficients for the various independent variables considered for this study which can be represented by the equation as below.

Rental Value = 3.720 + 0.665 (Carpet Area) - 0.088 (Age) + 0.077 (Bedroom) + 0.267 (Car park) + 0.143 (Metro) + 0.099 (Bus) + 0.104 (School) - 0.074 (Hospital) + 0.098 (Shop)

Where 3.7 is a constant and the coefficients for the individual variables indicate the % impact of these variables on the rental values. Now from the equation, we can see that the carpet area has the strongest influence on the rental value followed by the number of car parks, which comprise the key structural attributes any tenant would analyse before deciding on a property. Apart from these two factors, we can see that proximity to the metro station has the highest co-efficient among other variables. The result is an indication that rental values of properties located in close proximity (<500 m) of metro buildings have a positive impact of 14.3% than those that are away (>500 m) from the metro stations. We can also interpret from the results that property age and proximity to hospitals have a negative impact on the rental values of properties. It is a well-known fact that assets depreciate over a period of time and the building condition deteriorates with age and as a result the rental yield also drops unless it is refurbished/reconditioned intermittently. Another important factor that was observed is the negative influence of proximity to hospital/healthcare facility. We can relate this to the present pandemic scenario, with the growing fear psychosis that the spread of pandemic has caused among the people that tenants would now prefer to stay far from healthcare facilities than nearby.

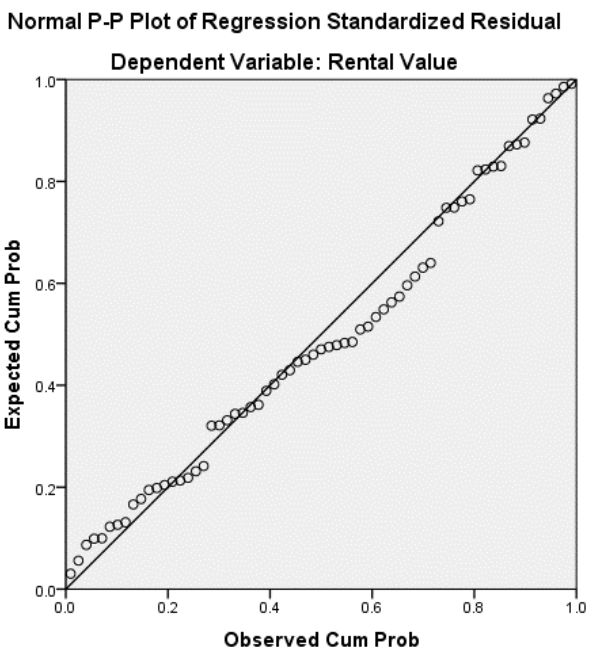

Figure 3. SPSS Normal P-P Plot for Residential Buildings

The regression model will not be able to accurately associate variance in the outcome variable with the correct predictor variables if the predictor variables are highly correlated and can lead to incorrect inferences (Daoud, 2018). This is also referred to as multicollinearity. SPSS provides the option to check for this by calculating the Variance Inflation Factor (VIF). The model is said to be valid and reliable if the VIF is below 10 and in the best case these will be below 5. The values of VIF obtained in this study as shown in Table 4 are well within these limits and hence can be considered to be accurate.

To make valid inferences from the model, residuals of regression is expected to follow a normal distribution i.e., the data points shall follow the diagonal line (Holmgren, 1995) and

the Predicted Probability (P-P) plot Figure 3, that checks for the differences between the observed value of the dependent variable and the predicted value confirm a normal distribution.

Hence, all of the tests confirm that the model is accurate and reliable. Similarly, the data was analysed for commercial buildings separately. The standardized SPSS output summary for commercial properties (including blue line and metro line) are presented in Table 5 & Figure 4.

Table 5. SPSS Output for Commercial Buildings

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.811[a]	.657	.560	.38923	2.038

a. Predictors: (Constant), Bus, Age of the Building, Carpet Area, Metro

b. Dependent Variable: Rental Value

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	4.325	.406		10.65	.000		
	Carpet Area	.000	.000	.696	3.843	.002	.747	1.339
	Age of the Building	-.095	.144	-.121	-.658	.521	.721	1.386
	Metro	.186	.223	.162	.834	.419	.646	1.549
	Bus	-.002	.217	-.002	-.011	.992	.678	1.475

a. Dependent Variable: Rental Value

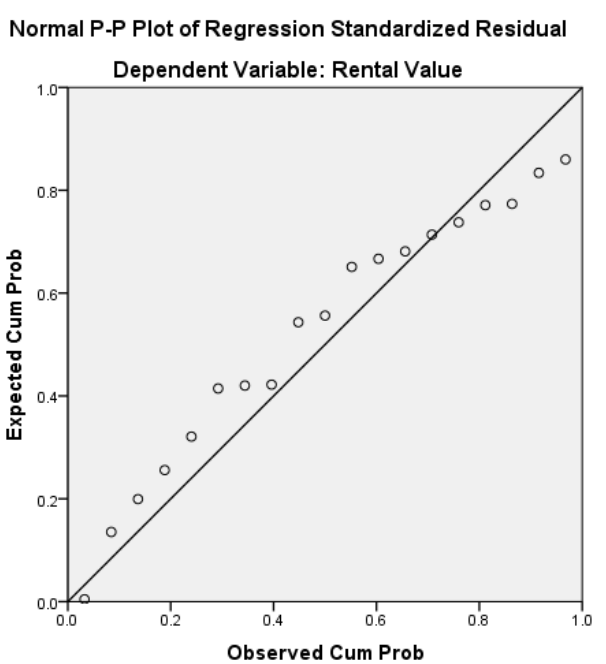

Figure 4. SPSS Normal P-P Plot for Commercial Buildings

The results presented in Table 5 provide the coefficients for the various independent variables considered for study on commercial buildings which can be represented by the equation as below.

Rental Value = 4.325 + 0.696 (Carpet Area) - 0.121 (Age) + 0.162 (Metro) - 0.002 (Bus)

The results indicate that apart from the carpet area, proximity to metro station buildings has the highest impact/influence of 16.2% on the rental values of commercial buildings. It is to be noted that, attributes not significantly relevant to commercial buildings such as proximity to hospitals, car parks, bedrooms etc., were not considered for commercial buildings. The test statistics as presented in Table 5 & Figure 4 also confirm the model to be accurate.

Impact of Metro Rail Project on Socio-Economic Aspects of Life

The second objective of this study was to investigate the impact of the metro rail projects on the socio-economic aspects. For this assessment, key environmental and neighbourhood attributes as mentioned in Table 2 were adopted. The respondents with distance < 500 m to the metro stations, were asked to rank the attributes on a Likert scale of 1 to 6, with 1 for an attribute that has been positively impacted/benefitted and 6 for an attribute that has been negatively impacted/deteriorated. A total of 52 valid responses were obtained from locations with less than 500 m distance to metro stations. The results are summarized in. The results are summarized in Table 6.

As it can be seen from the results obtained, the respondents ranked reduction in commute time as the first factor having significant benefits, employment opportunity as the second factor, and quality of life as the third factor. Household income was almost neutral, while ambient air quality and noise levels were ranked the lowest indicating the proximity to metro stations has negatively impacted the residents' / tenants' life about these aspects.

CONCLUSIONS

The present study has investigated the impact of a mega-urban infrastructure project viz, Metro Rail System on the rental values of properties. The study has contributed to the existing body of knowledge through the identification of various factors that influence the rental values of properties. The research has also adopted the novel hedonic regression analysis and has provided an indication of the extent of influence of these various attributes in addition to the aspect of proximity to metro rail projects. Thus, from the study, it is concluded that the real estate value is high in properties located to close proximity to the metro station than the properties located far away from the metro station. The study found out that the value of residential properties is impacted by 14.2% and commercial properties by 16.2% in close proximity of metro stations. The study has also assessed the impact of a mega infrastructure on socio-economic parameters. And also, it is found that the commute time of residents located close to the metro station is the most significant benefit realized and there exist impacts of poor air quality, high noise levels. This is probably one of the factors as to why commercial properties have more appreciation than residential buildings. The results of the study shall benefit tenants, property owners, property consultants and agents, institutional

agencies/firms, municipalities immensely. Also, further studies covering all of the metro lines, different cities, and also property sale values can be conducted on similar lines.

LIMITATIONS

The study was carried out during the period of the COVID pandemic and businesses, economic activities all over India and across the world are seeing the worst phase of the economic cycle in many decades. During the time of this study, India was going through a phase of low job growth, property sales, job cuts, and also stagnation in the sale and rental values, etc., and hence the appreciation impact as established by this study could be slightly lower. Secondly, the commercial buildings had received a low level of response as the economic activity was stalled during the period of this study. Even though models developed were found to be accurate and reliable from the statistical tests, further studies could be done with more samples.

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ASSESSING RISK FACTORS ON CIVIL ENGINEERING PROJECTS

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Abstract
Identifying and classifying the risk factors associated with projects have proven to be a valuable and a more productive approach. Good risk management increases efficiency and profitability in the construction industry. Risks and uncertainty in the construction industry can have negative outcomes on construction projects. This paper aims to identify the common risk factors in risk mitigation for civil engineering projects in Malaysia. Quantitative methodology which involved survey questionnaires were sent out to 350 respondents among contractors Grade G7 registered under the Construction Industry Board Malaysia with 47% responses collected. It was found that construction delay, late payment by client, unavailability of funds, poor communication among construction parties and coordination of works among construction were the common risk factors in risk mitigation and had significant impacts on their projects. To keep track of changes and continuously updated the mitigation plan, extensive risk assessment procedures and a rigorous process involving regular meetings among all members of the team should be conducted.

Keywords: *Risk mitigation; civil engineering projects.*

INTRODUCTION

Due to various sources of uncertainty, such as the performance of construction parties, availability of resources, environmental conditions, involvement of other parties, and contractual relations, the construction project is challenged by many predictable and unpredictable risks (Abdul-Rahman et al., 2015). Late payment by the client, inflation, price fluctuation, variation orders, tight project schedule, insufficient time to prepare a bid, inclement weather, default of personnel, design errors and ambiguous contract provisions, unstable politics, and accidents are among the most common contributing factors, according to a survey conducted by (Goh & Abdul-Rahman, 2013).

Many researchers have studied risks that are critical for success in project management, depending on product type and country attributes (Liu et al., 2016; Polat et al., 2014; Creedy et al., 2010; Chan & Au, 2009; Ahadzie et al., 2008; Westerveld, 2003; Hastak & Shaked, 2000; Akinci & Fischer, 1998). Recently, risk identification, assessment, and response tools and strategies have become more sophisticated and comprehensive, considering organizational capability, risk attitude, subjectivity, interrelation, and so forth (Böhle et al., 2016; Floricel et al., 2016; Bredillet & Tywoniak, 2014; Taroun, 2014; Cagno et al., 2007). Clear identification of risk events can help project managers plan more informed risk management, resulting in better project risk mitigation (Yim et al., 2015; De Bakker et al., 2012). Miller & Lessard (2001) insisted that risk response should focus on proactively mitigating the negative impact of project risks. Zou et al. (2007) also suggested that once risks are identified and analyzed, an appropriate response strategy must be followed to mitigate them. Olawale and Sun (2010) presented mitigation measures according to design changes, risks and uncertainties, inaccurate evaluation of project duration, complexity of work, and

non-performance of subcontractors.

Love et al. (2016) revealed that an authentic leadership style, empowerment of and active engagement with contractors, and focus on continuous improvement could significantly mitigate rework.

Risk in construction projects is an object of attention due to factors namely time, cost overruns and quality associated with construction projects. In order to meet project objectives in terms of time, cost, quality, safety, and environmental compatibility, such risks must be managed in construction projects (Kaur & Singh, 2018). Therefore, it is a must to define the techniques available when responding to certain risks. Risk mitigation is the action of working together by project participants to minimize the project's risk impact. This means that the participants must devise ways to reduce the project's risk impact. As a result, the parties involved can undertake a variety of tactics, including risk avoidance, risk mitigation, risk transfer, and risk acceptance (Kang et al., 2015).

Based on studies conducted by Abdul-Rahman et al. (2015); Bahamid et al. (2019); Nguyen and Nguyen (2020), it is worth to be highlighted that most of the identified and classified risks factors are similar between countries. Therefore, all risk variables must be recognised, assessed, and categorised in terms of their impact and likelihood of occurrence. This paper aims to highlight the common risk factors that construction industry players face while attempting to mitigate risk in civil engineering projects in Malaysia.

LITERATURE REVIEW

The possibility of risk removal associated with a specific project is unlikely, and the most that can be accomplished is the control of risk allocation to various organisations, as well as good risk management (Abazid & Harb, 2018). In the construction sector, analysing and managing risks is an important element of the decision-making process. The construction industry and its clients are heavily impacted by the high level of risks posed by the nature of micro and macro environments in particular to construction (Zavadskas et al., 2010). There are five (5) risk mitigation strategies specified by Konior (2019) comprising of avoiding, reducing, monitoring, transfer and accepting. According to Mahendra et al. (2013), risk mitigation can be explained as a strategy that reduces the probability or impact of an adverse risk event to an acceptable threshold. Olawale and Sun (2010) outlined mitigation strategies for design modifications, risks and uncertainties, inaccurate project duration estimates, work complexity, and subcontractor non-performance. According to Love et al. (2016), an authentic leadership style, empowerment and active interaction with contractors, and a focus on continuous development can all help to reduce rework. Construction firms should include the following reserves during the bidding stage, based on study by Lee et al. (2017), in order to prevent cost and schedule overruns: a contingency reserve to cover prospective changes and a management reserve to address unplanned changes. The mark-up cost factor is generally to cover with associated project risk (Dikmen et al., 2007). When it comes to global project risks, appropriate project funding, the inclusion of dispute resolution and escalation clauses in the contract agreement, and appropriate insurance are all viable mitigation measures (Al-Bahar & Crandall, 1990). Therefore, all the risks factors shall be identified, classified and categorized against their impact and likelihood. Hence, this research is to identify the risk factors in mitigating risks for civil engineering projects in Malaysia.

METHODOLOGY

A quantitative methodology in the form of a survey questionnaire was conducted with Grade G7 Contractors registered with Malaysian Construction Industry Board. Piloting was conducted prior to the main survey so that potential problems of the questionnaire could be identified and rectified at the earliest stage. To achieve that, a five-point Likert Type Scale was used to rank the findings. Survey questionnaire was distributed to 250 respondents through postage and 100 Google Form where 118 respondents replied, which contributed to 47% of total respondents. It shows that the response was quite high and acceptable for the findings.

Respondent's Profile

The purpose of these questions is to obtain demographic data from the respondents which include their designation, working experience and involvement in risk mitigation in civil engineering project. The relevancy of data exposes the respondents' practices in risk mitigation plan and actions following their experience in handling civil and infrastructure projects.

Table 1. Types of Company / Organization, Respondent's Designation and Years of Experience in Construction Industry

Item	Demographic Data	Response	%
1	Types of Company / Organization	Contractor	43%
		Consultant	34%
		Government Owned Company	15%
		Government	3%
		Project Management Consultant (PMC)	3%
		Public Listed Company	2%
		TOTAL	**100%**
2	Respondent's Designation	Quantity Surveyor	36%
		Project Manager / Risk Manager / Other Managerial Levels	24%
		Project Director	15%
		Engineer	10%
		Head of Department	7%
		Others	5%
		Project Executives	2%
		Architect	1%
		TOTAL	**100%**
3	Years of Experience in Construction Industry	0 – 5 years	16%
		6 – 10 years	21%
		10 years and above	63%
		TOTAL	**100%**

The types of organisations, responder designations, and years of experience in the construction business are shown in Table 1. 43% of respondents worked with contractors, 34% for consulting firms, 15% for government-owned corporations, 3% for government staff and project management consultants, and 2% for publicly traded companies. The questionnaires were distributed at random, without appropriate ratio for the type of business or organisation.

It was found that 36% of the respondents were quantity surveyors, 24% were project risk managers or other managerial levels, 15% were project directors, 10% were engineers followed by Head of Departments with 7%, others from Administration, Health & Safety department with 5%, 2% were project executives and 1% were architects. 63% of the total respondents consisted of those who had more than 10 years of experience, 21% with 6 to 10 years of experience and 16% with below 5 years of experience. Majority of the respondents with more than 10 years of experience complements the strength of the findings.

Respondents' Perception on common Risk Factors

Table 2. Types of Risk Factors Commonly Experienced by Construction Industry Players

Type of Risk factors	Mean	Standard Deviation	Rank
Construction delay	4.2712	.69995	1
Late payment by Client	4.1271	.97443	2
Unavailability of funds	4.0763	.94423	3
Design and scope changes	3.9915	.83201	4
Poor communication among construction parties	3.9153	.97469	5
Coordination of works among construction parties	3.9068	.92438	6
Levels of competencies among construction parties	3.8983	.84114	7
Scheduling	3.8136	.83665	8
Ambiguous contract provisions	3.7119	.92544	9
Inflation and price fluctuation	3.7119	.93463	10
Project complexity	3.6949	.88200	11
Shortage in materials and labours	3.6864	.97577	12
Political environment	3.5932	1.09574	13
Improper intervention by Client	3.5763	1.02454	14
Others	3.0488	1.12109	15

Table 2 shows that the common risk factors experienced by the respondents are construction delay (4.27- very important), late payment by client (4.13 – very important), unavailability of fund (4.07-very important), design and scope change (3.99 – very important), poor communication among the construction parties (3.91 – very important) and coordination of works among construction parties (3.90 – very important). The risk factors discovered in this analysis were comparable to those found in a prior study (Bahamid et al., 2019). Inflation, accidents, permission delays, regulatory changes, client financial failure, lack of scope of works definition, design changes, and poor communication between interested parties are among the top ten risk factors. The lowest five mean score are project complexity (3.69 – very important), shortage in materials and labours (3.69 – very important), political environment (3.59 – very important), improper intervention by client (3.58 – very important), and others (3.05 - important). The mean of each risk factors scored between 3.50 and above which indicate 'very important'. According to Fashina et al. (2021), construction delays are a global issue that hinders projects from being completed on time, on budget, and with the intended quality. Delay factors related to clients or owners were identified, such as late payment, owner order changes during construction, poor communication and coordination with contracting parties, delay in the provision or delivery of project site, and lateness in the revision and approval of design documents (ii) related to contractors, such as underestimation or overestimation of project cost, difficulties in project financing, and lateness in the revision and approval of design documents.

Sabri and Isa (2020) mentioned payment issue in the construction business has caused considerable concern among industry participants. It produces severe cash flow issues for construction sector players, particularly contractors and subcontractors, and this situation might have a devastating effect on the contractual payment chain. According to Haron and Arazmi (2020), the three (3) most common causes of late payment by clients are client withholding payment, certification delays, and poor financial management, whereas the three (3) most common causes of late payment by main contractors are pay when paid, no formal contract agreement, and contractor withholding payment. Buyukyoran and Gundes (2017) revealed that the availability of sufficient funds to execute planned projects determines the success of construction contractors. It has also been commonly noted that any financial problem, regardless of the cause, results in payment delays, which causes project schedule delays (Seddeeq et al., 2019). According to a study conducted by Van Tam et al. (2021) the financial situation of stakeholders is a top crucial factor determining construction labour productivity. This is owing to the significant amount of capital necessary to meet project execution expenses on a daily basis.

Construction projects have been shown to be prone to multiple changes or problems during its delivery due to a range of circumstances, leading in cost or time overruns and change orders, all of which have a substantial impact on the construction project's performance (Durdyev & Mbachu, 2017). According to a study by Durdyev (2020), design flaws and incomplete designs are the leading causes of project cost overruns. The necessity of effective language delivery has often been emphasised among speakers, according to Ne'Matullah et al. (2021). In any industry, the capacity to clearly communicate with succinct information has contributed to increased productivity and advancement. Site engineers are in charge of conveying instructions to both domestic and foreign employees, as well as providing reports to management. Project reports, formal communication, and team meeting discussion were all mentioned as important communication channels in the construction sector by Harikrishnan and Manoharan (2016). According to Alaloul et al. (2021), the supervisor must communicate with the labourers about the tasks and production schedule in order to keep everyone on the same page when executing an activity on a construction project. Due to a lack of communication, mistakes and errors occur, causing delays, time waste, and financial loss, diminishing labour productivity. To keep costs to a minimum, fair communication between the supervisor and the workers is required.

CONCLUSION

The construction sector is notable for its risks and uncertainty, both of which can have negative consequences for construction projects. The analysis in this paper illustrates the common risk variables in risk reduction and objectives were met for civil engineering projects in Malaysia. Construction delays, late payments by clients, lack of funds, poor communication among construction parties, and work coordination among construction parties are all major risk concerns faced by Malaysian construction industry players. These risks have a significant impact on the projects.

All risk factors must be determined, identified, classified, and assessed against their impact and likelihood. Risk mitigation can be regarded workable once thorough risk identification and risk assessment have been performed. Prior to initiating mitigation activities, extensive risk assessment procedures must be completed. As a project progresses

and new risks surface, a rigorous process will become increasingly detailed. To follow those changes and update the mitigation strategy, regular meetings among all members of a project team within the firm and beyond are required.

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CONTRACTOR'S BARRIERS IN CONDUCTING STRATEGIC DECISIONS IN TENDERING

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Abstract
Malaysia's construction industry is rapidly growing from time to time. The bidding decision for construction projects is a very complex decision-making process which affected by several factors. The construction project usually obtains good quality, cost, time, and safety. The contractors will compete in the tendering process to get a project, and most of the construction work in Malaysia was awarded based on competitive tendering. With the limited information and time, the contractor has to decide whether to tender or vice versa. The paper explores the challenges in conducting strategic decisions in tendering among contractors in Malaysia. A set of questionnaires are used to collect the data for the study. The sampling method used in this study was random sampling and quota sampling. The study only focuses on the contractors in Klang Valley, as Klang valley is known as the heartland of Malaysia's industry and commerce. The data was gathered and analysed by using SPSS. The result of this study was in the form of ranking with the mean value as the ranking indicator. As a result of the questionnaire, most respondents agree that the biggest Challenges in conducting strategic decisions in tendering are the need of the contractor to win a project. The contractor must have sufficient data in deciding to tender. Adequate information regarding the project is vital as it acts as a reference for an estimator to estimate the project cost. Estimating is a critical factor that influences the contractor's success in the tendering and ensures that the contractor can do the work diligently as stated in the contract.

Keywords: *Strategic decision; challenges; tendering; contractors.*

INTRODUCTION

The main objective of the construction project is to obtain a good quality, cost, and time. Usually, for the client to assign a contractor, there was a process in selecting the contractor called tendering. Tendering is described as inviting interested contractors to submit their offers to execute specific packages of construction activities. The contractors will compete in the tendering process to get the project. In Malaysia, many construction works were awarded based on competitive tendering, which means that contractors need to have adequate knowledge and information to compete and make critical decisions throughout the entire tendering process. In Malaysia, the government used the system to obtain accountability, transparency, and fairness in awarding the project to the contractor. Therefore, the selection of the contractor is made based on the best offer, which the client generally will award the best contractor who submits the most reasonable offer. The tendering also will determine the profit and the performance of the contractors. Tendering involves the contractors undertaking strategic decisions that include financial, managerial, human resources, and physical resources before embarking on the project (Odusote & Fellow, 1992); (Opeyemi et al., 2016). Therefore, the contractor must plan the best tendering strategies to win tenders. All components such as knowledge, financial, stability of the company, and market condition should include in deciding to tender. It is not an obligation or a must for a contractor to undertake the strategies decision; however, the contractor who makes the strategic decision

may reduce mistakes and prevent an incapacity project or overdoing work. In winning tender, the most successful factor is when the contractor implements and practices the strategic decision in their tendering management. Contractors should make strategic considerations while deciding whether or not to tender on a project and determining the appropriate estimate that will let them secure the tender.

The tendering decision of construction projects is a very complex decision-making process which affected by several factors. With limited information and time, the contractor must decide whether to tender or vice versa (R. Awwad, 2016); (D.K.H Chua & D.Li, 2000). This situation shows how important for the contractor to make the decision. The only possible way for a contractor firm to survive and acquire its aims is by winning tenders and making a profit (Egemen et al., 2007). The contractor must plan the best tendering strategies to win tenders. All components such as knowledge, financial, stability of the company, and market condition should be included in deciding to tender. It is not an obligation or a must for a contractor to undertake the strategy's decision; however, the contractor who makes the strategic decision may reduce mistakes and prevent an incapacity project or overdoing work. There are many factors related to contractors who fail to deliver the construction project. One of the factors is that the contractors failed to estimate the cost of tender correctly due to their eagerness to win the project.

TENDER

Tendering is inviting prospective contractors to submit a tender to execute specified packages of a construction project. It is a method that many clients use to get the best pricing for a project in the construction industry (Greenhalgh et al., 2021). It is also one of the most used methods of getting contractors for building projects today. Generally, there are three tendering methods: Open Tender, Selective Tender, and Direct Tender/ Negotiated Tender (Greenhalgh et al., 2021). Usually, the client will use any method of tender based on elements such as the size and complexity of the project, construction time, risk levels, and budget. Choosing the correct tendering method is critical to avoid incurring excessive fees. Tender Preparation, Call for Tender, Tender Evaluation, Tender Report, and Tender Management are the five primary steps of the tendering process. Many tendering processes must be completed at these stages. The tendering procedure involves a wide range of parties, where it usually involves three key parties: the client, the contractor, and the consultants.

Generally, tendering is when the interested contractor is invited either by open or selective tender to carry out a specific work by bidding on the tender. Contractors' top four most common mistakes in tendering are bid calculation mistakes, clerical errors, wrong assumptions, and documents error (Kamil et al., 2018). The contractor should interpret the need of the document in tendering to fulfil the tendering requirement, especially on specification and pricing.

Open Tender

In Malaysia, all registered contractors with the government and agencies such as the Construction Industry Development Board (CIDB) are eligible to participate in an open tender. An open tender is commonly used to select the best-qualified contractor for a building project in the construction sector. It established a fair competition, and the contractors' prices

are usually workable and reasonable. The client will publicise the open tender invitation in local publications. Essential project details, such as work duration, the scope of work, and the deadline for tenders, will be included in the advertising. This method allows the client to select the best contractor with the lowest workable and reasonable price. Furthermore, it provides an equal opportunity to all interested contractors, especially newly registered contractors. It also establishes a healthy rivalry between the tenderers and allows the client to select the most cost-effective offer.

Selective Tender

A selective tender is a process in which the client only offers a limited number of competent contractors. Usually, this method is chosen by clients because it can reduce the risk of choosing an unqualified contractor and helps the client identify a highly potential contractor that suits the specific work/specialist work. In most cases, the client will shortlist a small number of contractors, allowing the competition between contractors on a smaller scale than Open Tender.

Direct Tender/Negotiated Tender

Contractors are required to submit their project proposals based on the client brief. The client will invite a few selected contractors to negotiate the proposed construction project directly in a negotiated tender. The contractors who are usually invited have previous project experience and specialised competence. Based on the negotiations, the client will choose the best contractor. This method established the fastest process compared to the other methods. The reason for using this method is that clients want to undertake specialist work and save time on tendering.

FACTORS THAT INFLUENCE TENDERING DECISION

According to Alsaedi et al. (2019), The size of the work, the type of the work, the company's strength, the design quality, the rate of return, and the project cash flow are the top six factors to be considered in deciding whether to tender or not to tender. When a contractor receives an invitation to tender on a project, they must first decide whether to tender or not to tender. The contractor must make sure that they have the capabilities to undertake the work with sufficient resources, finances and others. The contractors must make vital decisions and look for projects in which they may participate to continue in business. On the other hand, participating in a tender on all accessible projects is not preferable; instead, it is critical to choose those relevant tenders for the organisation (Hanák et al., 2021). Many scholars have lately focused on aspects that influence. The possibilities of winning the tender and the capacity to complete the project with allocation for profit should all be factors in a contractor's choice to tender. Too many projects in hand will impact the contractor to manage their resources.

ADVANTAGES OF STRATEGIC DECISIONS IN TENDERING

Estimating Costs Accurately

It is critical to estimate the cost of a project accurately. The procedure of cost estimating is known as the fundamental in any tendering activity. It significantly impacts the possible profit or loss and the client's faith in the contractor's ability to complete the job. According to Kamil et al. (2018), having a good estimate capacity allows a contractor to provide the most accurate and acceptable cost submission for tender submission. The contractor may submit the best pricing with the best offer by making strategic decisions. It is in sync with the discussion conducted by (Alumbugu et al., 2014). It stated that the technique of estimate preparation, project data available, the estimator, and other elements that might impact the estimate determine the accuracy of an early estimate. The benefit of accurate cost estimates cannot be emphasised. To put it differently, a contractor that fails to estimate correctly might cause financial challenges and contribute to the inability to complete the specified work as stipulated in the contract (Kamil et al., 2018).

Client Relationship

The contractor and the client have a clear relationship. The client pays, and the contractor will deliver his services. Client satisfaction is higher when the contractor's work or services are satisfactory (Cheng, 2008). According to (Leniak, 2015), an invitation to tender should not be ignored because it provides the contractor with the opportunity to develop and preserve a lengthy relationship with the client. A strong and long-term client-contractor relationship can be established with the trust created based on the project. A good working relationship between the contractor and the client will help them work together on a future project. It will provide the contractor with a future opportunity and eventually result in a win-win situation for both the contractor and the client. The decision is crucial because it is about the possibility of winning the tendering and will result in the contractor's performance, whether the contractor will finish the project as planned and gain expected profit. The contractor needs to select the appropriate invitation to tender and contract that suits them because it determines the contractor's survival and chances of winning the tendering. The consequence of participating in the inappropriate tendering invitation will tarnish the contractor's reputation and relationship with the client. The contractor could not simply ignore the invitation as the invitation comes with the opportunity to retain a long relationship with the client (D.K.H Chua & D. Li, 2000).

On-Time Project Completion

The contractor and the client have a clear relationship. The client pays, and the contractor will deliver his services. Client satisfaction is higher when the contractor's work or services are satisfactory (Cheng, 2008). According to (Ajayi et al., 2012), choosing the best contractors for a proposed project is crucial because the contractor has a significant impact on the project's development and success. Choosing the right and competent contractor ensures that the project is completed on time accordingly. As a result, the project will be completed on schedule. A completed project on schedule and at a high standard will optimize earnings while also avoiding possible conflicts.

RESEARCH METHODOLOGY

This section presents the methodology involved in identifying the contractor's barriers in conducting strategic decisions during tendering. The respondents' demographics, data collection technique, and analysis method are also discussed in this section. In preparation for the paper proposal, the existing issues were observed through journals, and the problem statement, aim, objective, and scope were identified and determined based on the problems. This study idea also continues the previous study titled contractor's mistakes during tendering. For the Literature Review, the author decided to use secondary data from journals that have mostly been retrieved from digital libraries, journals, student papers from universities, and trusted websites. According to the study, the author has compiled and interpreted the literature review to present the content and synthesize the critical data.

Respondents

The information and whereabouts of the contractor's companies are identified through the contractors' registration at Construction Industry Development Board (CIDB) website. The study respondent for this paper is the construction parties who are Contractors registered under Construction Industry Development Board (CIDB) website to gain their opinion regarding exploring the contractor barriers in conducting strategic decisions in tendering.

Sampling

The sampling method used in this study was random sampling and quota sampling. Random sampling ensures that the sampling is not limited to a specific contractor grade. Meanwhile, the Quota sampling method is used because many contractors are registered under CIDB. By using this method, the scope will be reduced to the contractor located in Klang Valley only.

Questionnaire Design and Analysis

For the primary data for this study, the author designed the questionnaire survey in the google form and distributed it to the contractors via email that was retrieved from the internet, Telegram, other social media, and communication apps platforms. The questionnaire structure is close, whereby the respondent chooses their answer based on the options given. The questions are pretty straightforward – the contents of the questionnaire are obtained after careful reading and interpretation of the literature. The questionnaire consists of two sections: the section for the respondent's background and the section to identify the challenges in conducting strategic decisions in tendering. Thus, the questionnaire data analysis results are used to achieve the study objectives. The survey was undertaken quickly due to the limited time, and the author only achieved 60 respondents. Even the feedback is relatively small in numbers compared to the overall number listed on the website. It is still reliable because everyone's opinion is counted. The data was gathered and analysed by using SPSS. The result of this study was in the form of ranking with the mean value as the ranking indicator. The result was discussed together with the literature review to get the findings. Then the study is concluded accordingly based on the discussion and findings. The questionnaire uses a five-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5).

RESULTS

This section presents the results from the respondent's perception, ranking of variables, and comparison from the previous study. Based on Table 1, the respondent's profile is distributed by selected demographic characteristics. This table shows the frequency of contractor's grade, years of experience, and the value of projects mainly involved. A total of 60 contractors participated in this questionnaire survey, contributing to Table 2. A summary of the demographics and results of the questionnaire is summarised and presented below.

Table 1. Demographic of The Respondent

Contractor's Grade			Years of Experience			Value of Project Mainly Involved In		
Contractor Grade	**Frequency (No)**	**Percentage (%)**	**Years**	**Frequency (No)**	**Percentage (%)**	**Value of Project**	**Frequency (No)**	**Percentage (%)**
G3	6	10.00	< 2 years	12	20.00	Less than RM1 mil	20	33.33
G4	12	20.00	2 – 5 years	14	23.30	RM1 mil – RM10 mil	16	26.70
G5	16	26.70	5 – 10 years	16	26.70	RM10 mil – RM50 mil	14	23.30
G6	6	10.00	10 years and above	18	30.00	RM50 mil – RM100 mil	10	16.70
G7	20	33.30						

Based on Table 2 shows the top 7 challenges in conducting strategic decisions. The biggest challenges agreed by the respondents for conducting strategic decisions in tendering are the need for the contractors to win a project. It is ranked first with the highest mean value of 3.50. It can be said that winning the project is in the highest-ranking probably because the contractor depends on its ability to win the tendering for its survival. The need for work is one of the most significant driving forces for a contractor to submit bids for a construction project (Prajapati et al., 2015). The contractor desperately wants to win the tender for income and maintain workers' employment. Therefore, the contractor might not make the strategic decision because they always go as best as possible to win the tender.

Table 2. Result of The Respondent

Challenges	Rank	Mean	Std. Deviation
Excessive Eagerness to Win a Project	1	3.500	.9002
Insufficient Qualified Technical Staff	2	3.400	.9685
Insufficient time	2	3.400	.7701
Limitation of data	2	3.400	.8944
Financial Capacity	3	3.200	1.0635
Inexperience in strategies decisions	4	3.067	1.0483
Management Practice	5	2.933	1.2848

Secondly, the rank of the challenges for conducting strategic decisions in tendering is followed by insufficient qualified technical staff to undertake strategies decisions in tendering, time limitation, and lack of data to undertake the strategies decision with a mean value of 3.40. It can be a challenge for a contractor because the contractor might accept many tendering at one time. This study takes respondents from various grades of contractors in Malaysia. Contractors' grades 1 – 4 may lack qualified personnel to undertake strategies tendering decisions because of the capacity of the contractor's firm. So, the contractor's

capacity to take the overload works might affect why contractors decide not to make the strategic decision. "Tendering is a complicated and time-consuming process in terms of time. Usually, the time to tender depends on the size, complexity, and high value of the project takes longer than a typical and straightforward project" (A. Zainon et al., 2016). However, not every contractor can meet the time given; therefore, the contractor does not have adequate time to conduct strategic decisions. To make strategic decisions, the contractor needs to collect appropriate data and information, especially on the specification and material, to have accurate estimating. Estimating is a crucial factor that influences the success of winning the bid and doing the work smoothly. Thus, it can conclude that having adequate data is vital. However, not all contractors possess sufficient data. "Due to the complex nature of tendering, the data to be obtained relies on different personnel and outside information" (A. Zainon et al., 2016).

Lastly, even though lack of experience in strategic decisions and Management Practice ranked lowest in the mean value of 3.06 and 2.90, the contractor also needs to look into it. It is also a part of the contractor's challenges to be faced by the contractor in undertaking strategic decisions. The lack of experience of the personnel might affect the strategic decision because not everyone is capable of doing the tendering strategies. It takes much experience to decide which tender may give more profit than another tender. The management practice can also be one of the challenges because good management practices always give a better output to the company than the contractor company that does not have proper management practices. It is understood that usually, a higher grade for the contractor may have good management practices compared to a lower grade.

CONCLUSIONS

It is concluded that the objective has been achieved through the survey and analysis. Based on the investigation, the biggest Challenges agreed by the respondents for conducting strategic decisions in tendering are the need for the contractors to win a project. The second-highest challenges for achieving strategic decisions in tendering are shared between inadequate qualified technical staff, time constraints, and lack of data which sufficient data must be possessed in the strategic decision. The lowest rank in the challenges of strategic decisions is lack of experience and management practice, and the last two factors may not be crucial. However, it also needs to look into because it contributes to the challenges in conducting the strategic decisions. Factors may not be crucial. However, it also needs to look into because it contributes to the challenges in conducting the strategic decisions. All components such as knowledge, financial, stability of the company, and market condition should be included in deciding to tender. It is not an obligation or a must for a contractor to undertake the strategy's decision; however, the contractor who makes the strategic decision may reduce mistakes and prevent an incapacity project or overdoing work.

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ENHANCING PRODUCTIVITY IN GREEN CONSTRUCTION PROJECTS (GCP) THROUGH STRATEGIC MANAGEMENT STRATEGIES: EXPLORATORY FACTOR ANALYSIS (EFA)

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Abstract
The previous study suggested a different management technique to increase construction productivity, however, they are rarely given priority based on their contributions. Focusing on Green Construction Projects (GCP), this study intends to close the knowledge gap by highlighting the crucial management strategies that can improve productivity in the area. To achieve this goal, a comprehensive literature review was conducted to develop a conceptual framework that is considered to have constructive relationships with productivity performance. Based on the prior studies, a total of thirty-two (32) associated items are found and used to construct a questionnaire survey to gather data. The Exploratory Factor Analysis (EFA) was applied to the collected data which gave rise to the five (5) component factors affecting GCP productivity with a total variance percentage is 72.113%. The key component factors can be broadly categorized into (i) Government Regulation & Policies, (ii) Workforce Development, (iii) Project Management and Administration, (iv) Innovative Construction Technology and Technique Adoption, and (v) Effective Site Management. According to the results, it was found that KOM (Kaiser-Meyer-Olkin Measure of Sampling Adequacy) equals 0.9 which is very close to 1. Since each factor loading variable is greater than 0.4, all components met the Factor Analysis rule. The highest Eigenvalue is on Project Management and administration Factors (18.175), and the lowest is on Government Regulation and Policies (1.154). It is critical to comprehend all potential strategic management strategies so that industry practitioners can successfully manoeuvre and attain timely completion of GCP at lower costs, higher quality, and long-term sustainability.

Keywords: *Productivity; construction productivity; green construction projects, strategic management strategies, exploratory factor analysis.*

INTRODUCTION

The construction industry plays a significant role in economic development, especially for developing nations. It creates new career opportunities and provides solutions to social, environmental, and energy challenges. It has a direct connection with other sectors and consequently, has a major impact on the Gross Domestic Product (GDP) and economic development. Although many studies have been conducted on this topic, most of the research limited their study to traditional construction projects. Research on construction productivity in GCP is found very uncommon, henceforth, this research is contemplating the strategic management strategies for improving productivity, particularly in GCP.

In managing construction projects, integrating strategic management is a crucial concern in project management to ensure the effective completion of the projects. (Chinosky et al., 2000). Strategic management practices refer to how management performs a continuous appraisal of the business (Barbosa et al., 2020). It also involves the definition of an organization's strategy. Strategic management is long-term oriented, focused on future development potentials, substantial, holistic, and predominantly associated with the highest

management level which determines the vision, mission, and culture of the organization. The importance of management strategies in improving construction productivity has been strongly emphasized by many studies (Hwang et al., 2020; Javed et al., 2018; and Ofori et al., 2021), however, it is still lacking in a sustainable construction area (Hwang et al., 2017). Therefore, this research study aims to fill the knowledge gap by addressing the potential management strategies that can help improve the GCP's productivity.

LITERATURE REVIEW

The Paradigm of Green Construction Projects in Malaysia Construction Industry

The construction of green buildings is part of sustainable construction. Sustainable construction is applied throughout the entire life cycle of construction, from pre-construction to disposal of the building. Such construction aimed to reduce the impact of the construction practice on the environment through its planning and managing of a construction project complying with the contract document (Glavinich, 2008). To implement sustainable development goals in the Malaysian construction industry, the government introduced the concept of green building. Green building definition encompasses, a building planned, constructed, operated, preserved, or reused to preserve occupying well-being, enhance employee morale, utilise natural capital wisely, and reduce the effects on the ecosystem (Chandra, 2018). Other researchers define a green building as the act of developing, constructing, and building structures, and utilising an environmentally and resource-efficient procedure in various construction activities (Kamarudin et al., 2011). Therefore, green building is known as sustainable building (Hwang et al., 2012; Samari et al., 2013) or a "high-performance" building (Howe, 2010).

Driving toward sustainable development across the country, Malaysia is amid a robust increase in the level of green activities conducted by the Green Technology Masterplan (GTMP) (2017 – 2030) and several green initiatives (CIDB, 2016). To implement sustainable development goals in the Malaysian construction industry, the government has planned to implement sustainable building and infrastructure development in Malaysia by establishing policies and strategic planning to support the industry's move towards sustainable construction (CIDB, 2016). Since 2006, Malaysia has progressively advanced the delivery of green building projects. As reported in Green Building Index (GBI), as of July 2019, there are 507 GBI-certified green building projects in Malaysia. As the target goal in GTMP (2017 – 2030), the number will be increased by 550 green buildings by 2020, and the number will continue to increase by 1750 by the year 2030, inclusive of green buildings certified by various agencies and organisations such as MyCREST, Green Building Index, Green RE, etc.

Green Construction Productivity

According to M. I. Haloul (2016), green development in Malaysia is still new, and researching how these components would contribute to green development achievement is highly significant. Henceforth, understanding these variables and connecting all the key elements of green development is crucial. Particular attention should be paid to the fact that, given the influence of the mandate in the GTMP, environmental regulations are the driving force for green adoption (Dodge Data & Analytics, 2016). In Malaysia's construction industry

context, the alignment between the elements of construction project productivity and sustainability is still very rare and there needs to be more attentive to the integration of productivity in GCP (Mahat et al., 2019). The limited references make it challenging for the stakeholders to put together holistic strategies for productivity improvement to endeavour sustainable construction development. These matters critically need to be resolved since the government of Malaysia has planned to implement sustainable building and infrastructure development by establishing policies and strategic planning to support the industry moving towards sustainable construction.

Pursuing to green at least 1750 numbers of green buildings in Malaysia by 2030, construction productivity can be a significant and determining factor in achieving this target goal. However, the declining productivity in the construction industry creates a significant question mark for the attainment of this goal. According to previous studies, the development of green buildings is not as productive as it should be, which poses a significant challenge to the green aim because poor construction productivity frequently results in issues with cost and schedule performance (Hwang et al., 2020; Doloi et al., 2012; Gündüz et al., 2013). The capital costs of green building developments are perceived as higher than traditional buildings, leading to the inactive development of the green building industry (Dwaikat et al., 2016). This is due to the design and construction of green buildings, which are different from traditional buildings (Chan et al., 2009; Robichaud et al., 2011). To motivate the industry, firms/business organization are recommended to change their business models to maximize their profits from green constructions (Mokhlesian et al., 2012). Henceforth, this research indicated the adoption of strategic management strategies in the organization to enhance the productivity of GCP.

Strategic Management Strategy to Improve Green Construction Productivity

To determine the prevalent management strategies used by the construction sector to increase productivity, a thorough literature review was initially carried out. Findings from previous literature on construction productivity improvement strategies were identified. For this research, the author merely highlights the findings of productivity enhancement strategies of five (5) recent research studies, from the year 2016 to 2020. The outcome from the research done by The Singapore Contractors Association Ltd (SCAL), 2016; Javed et al., 2018; Pan et al., 2019; Zhan et al., 2020; and Hwang et al., 2020, will be used as sources of references for this research. Further to that, a study done by SCAL, (2016) recommended ways to help the industry improve productivity and enable the government to devise better policies and programs. The study suggested that to enhance the productivity of Singapore construction firms and practitioners, there is a need to create strategies to have firms compete through performance improvement and have productivity targets and attainments in line with all sectors of the economy. Nevertheless, Javed et al. (2018) investigated the complex interdependence of the factors in driving or hindering construction productivity at the industry, project, and activity levels in a systemic manner. The study conceptualised and validated a systemic framework for examining construction industry productivity and developed three causal loop diagrams (CLDs) for illustrating the dynamic structures that underpin the complex systems of the drivers and constraints. The study highlights five strategic aspects, namely, “policy formation”, “regulatory requirements”, “planning and design”, “project management and administration”, and “site construction”, and at industry,

project, and activity levels that potentially can be adopted in the Hong Kong construction industry.

Whilst Pan et al. (2019) embraced PESTEL (political, economic, social, technological, environmental, legal) framework for analysing the macro business environment external to a firm. The research revealed the commonalities of the constraints and strategies shared by the contemporary construction and built environments concerning productivity enhancement through a multi-case lens scrutinizing the construction industries of Singapore, Hong Kong, and the United Kingdom. The framework recognizes the potential to explain productivity within the dynamic construction business environment by studying the complexity of the strategies, thereby making a significant contribution to the construction productivity literature. On the other hand, Hwang et al. (2020) signify the effectiveness of productivity strategies and prioritized the result based on their real contributions. A total of thirty-three (33) indicators were found and grouped into four levels, namely, industry, company, project, and trade levels. Results showed that "planning and communication" is the most critical management strategy category for productivity improvement, followed by "logistics," "project strategic management", "human resources", and "on-site management".

For in-depth productivity analysis within the context of the construction industry, Zhan et al. (2020) demonstrate a novel mixed-methods design that develops a systemic framework of construction Total factors Productivity (TFP) enhancement. The study measured the TFP of the construction industry, examined the systemic nature of its influencing parameters, explored its relationship with these parameters, and identified the dynamic nature of construction productivity enhancement measures and strategies. The identified strategies are to formulate a strategic plan, encourage technological innovation, build a sustainable construction workforce, and improve effective construction management. The measures under each strategy are illustrated by CLDs in the framework, indicating that the strategies should be adopted systematically for maximized synergies.

Even though the literature has shown that productivity improvement strategies are restricted to traditional construction projects, the outcomes will be adopted and practiced in the formulation of a questionnaire survey, focusing on GCP in the Malaysian construction industry. Based on the previous research, this study has identified a total of thirty-two (32) associated variables as potential strategic management strategies to enhance GCP productivity, as shown in Table 1. These variables are then used to develop a questionnaire survey to gather data for further analyses.

Table 1. Potential Strategic Management Strategies to Enhance GCP Productivity

Potential Strategic Management Strategies to Enhance GCP Productivity		**References**
1	Provides strategic guidance and a clear vision for productivity enhancement	SCAL (2016); Javed et al. (2018); Pan et al. (2019)
2	Develop productivity measurement standards for the construction industry	SCAL (2016); Pan et al. (2019); Zhan et al. (2020)
3	Link productivity assessment with tendering processes	Pan et al. (2019); Zhan et al. (2020
4	Incentivize manpower development, technology adoption and capability building	Pan et al. (2019)
5	Assess productivity and innovation of tenderer's technical proposal to secure suppliers of equipment and material.	Javed et al. (2018); Pan et al. (2019); Hwang et al. (2020)

Potential Strategic Management Strategies to Enhance GCP Productivity		References
6	Manage and measure construction productivity from a whole project life cycle perspective	SCAL (2016); Pan et al. (2019)
7	Develop comprehensive training and knowledge transfer programs at all levels	SCAL (2016); Javed et al. (2018); Pan et al. (2019); Zhan et al. (2020); Hwang et al. (2020)
8	Contractor involvement during the design stage	SCAL (2016); Hwang et al. (2020)
9	More complete and firmed-up design	SCAL (2016)
10	Demand excellence in both quality and quantity of work	Javed et al. (2018)
11	Leverage organisational expertise and best practices across the business	Zhan et al. (2020)
12	Promote collaborative procurement	Pan et al. (2019); Hwang et al. (2020)
13	Good coordination with multi-layer subcontractors	SCAL (2016); Javed et al. (2018); Zhan et al. (2020)
14	An effective and efficient communication system	SCAL (2016); Javed et al. (2018); Pan et al. (2019); Zhan et al. (2020); Hwang et al. (2020)
15	Good management control of the project team	Javed et al. (2018)
16	Considering the work of specialists and outsourced work	SCAL (2016)
17	Use effective performance measurement tools to drive efficiency and support innovation	SCAL (2016); Pan et al. (2019); Hwang et al. (2020)
18	Modernise logistics, materials management, and materials handling	Hwang et al. (2020)
19	Share knowledge of construction technologies, methods and practices	Zhan et al. (2020)
20	Adopt BIM as a common project management platform throughout the whole project life cycle	SCAL (2016); Pan et al. (2019); Zhan et al. (2020)
21	Envelop robotics technologies	Zhan et al. (2020)
22	Mechanise and automate whenever possible	SCAL (2016); Zhan et al. (2020)
23	Make greater use of prefabrication, pre-assembly, modularisation and off-site fabrication techniques and processes	SCAL (2016); Javed et al. (2018); Pan et al. (2019); Zhan et al. (2020); Hwang et al. (2020)
24	Utilise new technologies such as information and communication technology (ICT) in general, with building information modelling (BIM), radio-frequency identification (RFID), Virtual Reality (VR), Big Data etc.	SCAL (2016); Pan et al. (2019); Hwang et al. (2020)
25	Undertake and invest R&D on relevant issues, especially on green technology	Pan et al. (2019); Zhan et al. (2020)
26	Improved buildability and constructability standards	SCAL (2016); Javed et al. (2018); Pan et al. (2019)
27	Increased collaboration between project partners	SCAL (2016); Javed et al. (2018)
28	More effective project planning, scheduling and monitoring	SCAL (2016); Javed et al. (2018)
29	Better management of concurrent operations at site	Javed et al. (2018)
30	Quality of craftsmanship	Javed et al. (2018)
31	Measuring productivity systematically	SCAL (2016); Pan et al. (2019)
32	Re-engineering of designs	SCAL (2016)

RESEARCH METHODOLOGY

This research carried out an extensive literature review from multiple sources, such as "Green Construction" and "Construction Productivity" websites, reports from public and private institutions, articles, and journal papers, to provide a better understanding of construction productivity as well as green construction development in Malaysia construction industry. After doing a literature assessment of all research work related to construction productivity and project performance, variables determining strategies for improving GCP construction productivity are identified (see Table 1). Following that, a comprehensive list of the attributes discovered through the literature review was designed, and a survey questionnaire was subsequently developed to capture the emerging issues and problems in GCP productivity. The collected data were analysed by the Statistic Package for Social Science (SPSS) version 26 statistical software.

Questionnaire Survey

A questionnaire survey was conducted for this study to examine the potential strategic management strategies in GCP productivity. The survey was first reviewed by a construction expert to ensure that it was free of common errors such as leading, ambiguous, or double-barrelled questions. Following their suggestions, the necessary adjustments were made to develop the final survey. In this research, the respondents are restricted to construction practitioners, designated as construction engineers and contractors. These two target population frames comprised professional engineers registered under the Board of Engineer Malaysia (BEM) and Grade G7 contractors registered with the Construction Industry Development Board (CIDB), who have experience in at least one GCP. Respondents were selected based on their affiliation as green construction practitioner and the list are extracted from the Green Building Index (GBI) website, CIDB Directory of Construction also from the previously completed GCP. All the questionnaires were sent out to the respondents manually (postage) and through e-mail. A total of 400 sets of questionnaires were sent out and 153 (38.25%) questionnaires were received. The useful data samples found 138 and 15 samples found missing information or not fully completed is consider not usable. It is found that 90.0% of data is used which is further processed for analysis purposes. According to Moyo & Crafford (2010), contemporary built-environment survey response rates range from 7% to 40%, in general, therefore the received survey response is accepted.

Topics on construction productivity focusing on GCP were used in the questionnaire and were extracted from reviews of the literature, resulting in the formulation of a questionnaire divided into two sections. Section one on the respondent's profile obtained personal information on current designation, years of experience in the Construction Industry, and GCP. A respondent with experience in GCP is also asked about the common type of building or civil engineering project that they've worked on. Section two sets questions on strategies to enhance productivity in GCP, whereby its consisting of thirty-two (32) variables derived from the literature (see Table 1). The respondents were required to indicate their level of agreement, with these measures and their practices influencing productivity in GCP.

The data analysis started with univariate data screening which included the examination of missing data, item normality, and the detection of possible outliers. In this study, data collected from the questionnaire survey are tested with two major data screening analyses:

normality and outlier tests. The normality of the data is confirmed with skewness and kurtosis values. The skewness is a measure of symmetry, while kurtosis is a parameter that describes the shape of a random variable's probability distribution. The results show a normal distribution of all thirty-two (32) items. An outlier test is an additional step of the data screening process as it investigates unusual data. The 5 % trimmed mean, and Z-score is used to detect outliers. The items with a difference between mean and 5% trimmed mean greater than 0.2. The results show that the arithmetic means and 5% trimmed means range from 0.02 to 0.1. The Z score values are also within the allowable limit of 3. Therefore, it can be concluded that there is no non-normality and outliers in the collected data and that they can be used to perform the Exploratory Factor Analysis (EFA). Descriptive analysis was employed to gain a feel for the data and to consider whether the obtained data were suitable for multivariate analysis and could be used as one data set. The data from these measurements form the variables used in the EFA, which tested the validity and reliability of the factors. EFA is a data reduction technique used to reduce many variables to a small set of underlying factors that summarize the essential information contained in the variables (Richard et al., 2007). More frequently, factor analysis was used as an exploratory technique to summarize the structure of a set of variables.

RESULT AND DISCUSSION

The quantitative method has been used for analysing data through SPSS version 26. To test the accuracy of the questionnaire, Cronbach's Alpha Coefficient (α) of the questionnaire was determined. Tavakol & Dennick (2011) suggested that the acceptable values of Cronbach's alpha would range from 0.70 to 0.95. Consequently, the coefficient (α) was 0.986 indicating that the questionnaire was highly reliable.

Section 1: Respondent Profile

The respondents' profiles were based on job designation, also total experience in the GCP. These profiles are important to study how the different groups of respondents perceive strategic management strategies in productivity enhancement in GCP. As portrayed in Table 2, most respondents have extensive experience dealing with GCP for more than five (5) years. 92% of engineer respondents and 76% of contractor respondents have experienced than five years of, particularly in GCP. Very few respondents have experience between 2 to 5 years with only 3.6% of the total respondents.

Table 2. The Demographic Background of Respondents

Experience in Green Construction Projects (years)	Contractor		Engineer	
	Frequency	(%)	Frequency	(%)
More than 10 years	28	36	20	33
6 to 10 years	28	36	35	59
2 to 5 years	22	28	5	8
Less than 2 years	0	0	0	0
Total	78	100	60	100

Section 2: Results of Exploratory Factor Analysis

Exploratory Factor Analysis (EFA) was used in this study to group the criteria and features according to the literature findings in Table 2. In this study, five components of hypothesized factors determine the strategies that can be adopted in enhancing productivity has been grouped, namely (i) Government Regulation & Policies, (ii) Workforce Development, (iii) Project Management and Administration, (iv) Innovative Construction Technology and Technique Adoption and (v) Effective Site Management. Each of the five (5) components of factors influencing GCP consists of at least four (4) variables, so the components satisfied the rule in each component must contain at least 3 variables. Furthermore, each factor loading variable is greater than 0.4 indicating that all components with thirty-two (32) variables satisfied the Factor Analysis rule. To rank which components, the measures were rated on a five-point Likert scale. Likert-type or frequency scales use fixed-choice response formats and are designed to measure attitudes or opinions. The following scale measurement was used regarding mean scores, where 1 = Strongly Disagree ($\geq 1.00 \leq$ and <1.80), 2 = Disagree ($\geq$ 1.81 and $\leq$ 2.60), 3 = Neutral ($\geq$ 2.61 and $\leq$ 3.40), 4 = Agree ($\geq$3.41 and $\leq$ 4.20), and 5 = Strongly Agree.

According to the results, it was found that KOM (Kaiser-Meyer-Olkin Measure of Sampling Adequacy) is equal to 0.9 which is very close to 1. This indicates that the data are suitable for Factor Analysis. From Bartlett's test of Sphericity, if found that Chi-square is equal to 14699.628 with a p-value less than 0.01 meaning that the correlation matrix is not an identity matrix. Therefore, it can be concluded that all thirty-two (32) variables are correlated to each other and suitable for Factor Analysis. Table 3 presents the number of components, Factors loading, Eigenvalues, percent, and the cumulative percent of Eigenvalues. All five (5) components can explain the total variance which is equal to 72.113%.

Table 3. The Exploratory Factor Analysis (EFA) Result

		Component (Factor Loading)				
Component 1: Project Management and Administration		**1**	**2**	**3**	**4**	**5**
PM1	Good coordination with multi-layer subcontractors	0.775				
PM2	Effective and efficient communication system	0.899				
PM3	Good management control of project team	0.850				
PM4	Improve planning and coordination	0.894				
PM5	Contractor involvement during design stage	0.789				
PM6	Considering the work of specialists and outsourced work	0.777				
PM7	More complete and firmed-up design	0.800				
PM8	Use effective performance measurement tools to drive efficiency and support innovation	0.766				
PM9	Modernise logistics, materials management, and materials handling	0.750				
Component 1: (9) Factors			Eigen Value			18.175
			% of Variance			45.136
Component 2: Effective Site Management		**1**	**2**	**3**	**4**	**5**
SM1	Improved buildability and constructability standards		0.737			
SM2	Increased collaboration between project partners		0.794			
SM3	More effective project planning, scheduling, and monitoring		0.721			
SM4	Better management of concurrent operations at site		0.651			
SM5	Quality of craftsmanship		0.699			
SM6	Measuring productivity systematically		0.688			
SM7	Re-engineering of designs		0.701			
Component 2: (7) Factors			Eigen Value			2.322
			% of Variance			12.852

		Component (Factor Loading)				
Component 3: Innovative Construction Technology (ICT) & Technique Adoption		**1**	**2**	**3**	**4**	**5**
ICT1	Share knowledge of construction technologies, methods and practices			0.560		
ICT2	Adopt building information modelling (BIM) as a common project management platform throughout whole project life cycle			0.851		
ICT3	Envelop robotics technologies			0.731		
ICT4	Mechanise and automate whenever possible			0.721		
ICT5	Make greater use of prefabrication, pre-assembly, modularisation and off-site fabrication techniques and processes			0.665		
ICT6	Utilise new technologies with BIM, radio-frequency identification (RFID), Virtual Reality (VR), Big Data etc.			0.797		
ICT7	Undertake R&D on relevant issues especially on green technology			0.701		
Component 3: (7) Factors			Eigen Value			1.345
			% of Variance			5.173
Component 4: Work Force Development		**1**	**2**	**3**	**4**	**5**
WFD1	Develop comprehensive training and knowledge transfer programmes at all levels				0.786	
WFD2	Demand excellence in both quality and quantity of work				0.618	
WFD3	Incentivize manpower development, technology adoption and capability building				0.777	
WFD4	Leverage organisational expertise and best practices across the business				0.701	
Component 4: (4) Factors			Eigen Value			1.255
			% of Variance			3.398
Component 5: Government Regulation & Policies		**1**	**2**	**3**	**4**	**5**
GVP1	Provides strategic guidance and a clear vision for productivity enhancement					0.789
GVP2	Develop productivity measurement standards for the construction industry					0.799
GVP3	Link productivity assessment with tendering processes					0.701
GVP4	Assess productivity and innovation of tenderer's technical proposal					0.521
GVP5	Manage and measure construction productivity from a whole project life cycle perspective					0.731
Component 5: (5) Factors			Eigen Value			1.154
			% of Variance			5.554
			Cumulative % of Variance			**72.113**

The first component is "Project Management & Administration" which accounted for 45.136 percent of the total variance with an eigenvalue of 18.175. The component consists of nine (9) items and the factor loading for items in this criterion ranged from 0.750-0.894. The factor loadings (absolute value) on this factor are relatively large, especially for the *effective and efficient communication system* (0.899) and *improved planning and coordination* (0.894). This is aligned with the finding from Hwang et al. (2020), which indicates that planning and communication were likewise observed as critical for productivity. The second component is indicated as "Effective Site Management" factors. The component accounted for 12.852 percent of the total variance with an eigenvalue of 2.322. The total attributes in this component are seven (7) factors, and the factor loading for items in these criteria ranged from 0.597-0.794. The most prominent attribute of this component is *increased collaboration between project partners* (0.794). Collaboration is seen as a mainstay of efficiency improvements as it enables the project to deliver smoothly. Embracing collaboration in the processes such as design, material requirements planning, product delivery, and subcontractor management has significant potential for productivity improvement in the industry (Javed et al., 2018). The third criterion accounted for 5.173 percent of the total variance with an eigenvalue of 1.345. Factor loading for items in this criterion ranged from 0.534-0.797. The component considered

"Innovative Construction Technology (ICT) and Technology Adoption" factors, and it consists of seven (7) items. Innovation and technology adoption are considered among the key drivers of productivity in the construction industry. Leveraging the use of BIM technology to improve multidisciplinary collaboration can be an essential approach to increase productivity. The fourth component suggested the "Work Force Development" factors, and it consists of four (4) elements. Total variance criteria accounted for 3.398 percent with an eigenvalue of 1.255. Factor loading for items in these criteria ranged from 0.618-0.786. The highest factor loading value in this criterion is upon the "*development and comprehensive training and knowledge transfer programs at all levels*" (0.786). According to Javed et al (2018), increasing labour training initiatives could ease skills shortages and improve the quality of craftsmanship, henceforth, it will enhance the productivity of the projects. The fifth components are the "Government Regulation & Policies Factors". The component consists of five (5) items and the factor loading for items in this criterion ranged from 0.521-0.789. To improve the GCP productivity, the government should exert considerable efforts such as policies, regulations as well as enforcement (SCAL, 2016; Javed et al., 2018; Pan et al., 2019). The major policies include developing the construction workforce through training, encouraging innovation, applying new construction technologies and methods, and strengthening collaborations in the construction supply chain (Barbosa et al., 2017).

CONCLUSION

Productivity refers to the effective and efficient use of its resources in achieving the desired output. Although many studies have been conducted on the research topic, most of them focus on productivity in traditional projects. The limitation of the study in discussing productivity in GCP has created a knowledge gap, thus, this research tends to present a significant strategic management strategy that can be implemented in GCP. Further to this, industry practitioners can improve the productivity of GCP efficiently and effectively; by focusing and acting on the potential components of strategic management strategies. This study has made use of exploratory factor analysis (EFA), and according to the result, there are five (5) components influencing the GCP productivity with a total variance percentage is 72.113%. The results of this study can assist practitioners in making specific adjustments to conventional project management practices in achieving a more productive delivery of GCP. The findings of this study can also help them retain practical knowledge of such strategic management strategies and reduce productivity-related risks.

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IDENTIFICATION OF THE MAIN BARRIERS TO LIFE CYCLE COSTING IMPLEMENTATION IN MALAYSIA'S GREEN CONSTRUCTION PROJECTS

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Abstract
Life Cycle Costing (LCC) is a tool used worldwide to assess the expected economic performance of a building throughout its life cycle. The application of LCC within the construction industry is still lacking, especially in the development of green construction projects despite the many benefits it has been linked to. This paper aims to identify the main barriers in implementing LCC in green construction projects. The research adopted a quantitative method by conducting questionnaires survey distributed through traditional mail and e-mail as well as online platforms to 700 respondents from various backgrounds, namely architects, quantity surveyors, engineers, and other professionals. A total of one hundred and eighty-seven (187) completed and usable questionnaires were collected and analysed by using frequency descriptive analysis and by mean value using IBM SPSS Statistic 26. The findings indicate that barriers relevant to project clients and the government were the main barriers to LCC implementation in green construction projects. It gives an understanding that both clients and the government play significant roles in promoting the use of LCC. The findings are beneficial to industry practitioners of green developments as a reference to enhance the LCC process and to devise more effective strategies to promote acceptance of LCC in Malaysia's green construction projects.

Keywords: *Life Cycle Costing; barriers; green construction projects.*

INTRODUCTION

The use of Life Cycle Costing (LCC) is not something unfamiliar in construction industry. It is a tool use in built environment to evaluate a building's expected economic performance during its lifespan; from design stage until its eventual demolition (Boussabaine & Kirkham, 2004). With the increase interest for sustainable construction activities as well as green initiatives around the world (Kibwami & Tutesigensi, 2016), it would be expected for the same in LCC, since it has been commonly linked with such activities (Maisham, Adnan, Ismail, & Mahat, 2019). LCC allows decision-makers to obtain critical economic information in the form of short-to-long term costs and benefits of a project (Miah, Koh, & Stone, 2017). Several studies have been done covering on the area of LCC with relevancy to green construction practices or sustainable development (De Giacomo, Testa, Iraldo & Formentini, 2019; Khan et al., 2019; Ahmad Jasmi, Ayob, Abdul Rashid, & Mohd Rahim, 2018; Dwaikat & Ali, 2018; Zuo et al., 2017). Nevertheless, LCC implementation in the construction industry is still lacking and requires attention (Lim, Zhang, & Oo, 2018; Goh & Sun, 2016). Furthermore, the current state of LCC in green construction projects in Malaysia is still vague. Therefore, this paper aims to identify the main barriers in implementing LCC in Malaysia's green construction projects.

LIFE CYCLE COSTING

The use of LCC has expanded from its first application in procurement by the US Department of Defence (Epstein, 1996), to many other areas such as product design,

buildings, transportation, and technologies (Eriksson, Bisaillon, Haraldsson, & Sundberg, 2016; Ng, Zhou, Giannis, Chang, & Wang, 2014). The term 'life cycle costing' is used interchangeably with other terms such as 'life cycle cost analysis', 'whole life cost', and 'total cost assessment' (Shin & Cho, 2015; Mateus, Neiva, Bragança, Mendonça, & Macieira, 2013). It determines the sum of all expenses associated with a product or project, which would include the cost for acquisition, installation, operation, maintenance, refurbishment, discarding, and disposal (Standards Australia/Standards New Zealand, 1999). In built environment context, LCC is widely known as "a tool to assist in assessing the cost performance of construction work, aimed at facilitating choices where there are alternative means of achieving the client's objectives" and when the alternatives differ, permits similar basis of comparison (RICS, 2016).

LCC in Green Construction Projects

LCC has been associated with several benefits in its use in the construction industry, such as clearer future operation costs, enhance the ability to optimise costs at early design stage, higher probability for better value for money, allow evaluation of competitive alternatives and many more (Bruce-Hyrkäs, Pasanen, & Castro, 2018; Ashworth, 2010; Ellingham & Fawcett, 2006; Flanagan & Jewell, 2005; Langdon & Everest, 2004). Governments as well as practitioners across countries have taken various initiatives to promote its implementation (Chiurugwi, Udeaja, Hogg, & Nel, 2010) but it appears as though many in the industry is reluctant to engage in this economic practice (Higham, Fortune, & James, 2015). However, this does not mean that the industry should give up actively encouraging LCC as a tool for assisting decision makers in project evaluation, especially for green projects. The aim of green building or construction is to attain efficiency in its energy consumption and resources, together with achieving prolonged economic, environmental, and social health (Sahamir & Zakaria, 2014). Henceforth, LCC implementation in green projects is somewhat expected in the industry, since it is considered amongst the essential elements to achieve sustainability (Gundes, 2016). The Malaysian government has even welcomed LCC as a significant tool in supporting the Government Green Procurement (GGP), aside from seeing it as one of the awarding criteria for making decisions (KeTTHA, 2018). Thus, more effective efforts must be strategized by the industry to promote its application in this area.

Barriers in Implementing LCC in Construction Industry

LCC plays a significant role in the construction industry in both conventional building and green construction projects from the many benefits attached to it. However, many research have also documented barriers that hinders implementation of LCC in the industry. An investigation carried out in the UK revealed that the key factors preventing wider application of LCC in the construction industry were lack of understanding on LCC techniques, absence of standardized guideline and lack of reliable data input for LCC calculations (Oduyemi, Okoroh, & Dean, 2014). Other barriers identified are clients' reluctance to demand for LCC (Kambanou, 2020; Mohd Fairullazi & Khairuddin, 2011), their unwillingness to pay more and to spend time on LCC exercise (Lim et al., 2018). Among the barriers associated with professionals in the industry have also been recognized such as their lack of knowledge on the concept of LCC (De Giacomo, Testa, Iraldo, & Formentini, 2019), lack of understanding on methodological problems and limitations (Cole & Sterner, 2000) as well as lack of commitment (Lim et al., 2018) Government's lack of initiatives (Maisham et al., 2019; Wan

Hassan, Zakaria, & Ismail, 2014), and incentives to promote the use of LCC (Lim et al., 2018) also counted as LCC barriers. All barriers identified from previous researchers were compiled, analysed and categorized into six (6) main factors which are client, professionals, government, data, LCC and project-related factor as tabulated in Table 1.

Table 1. Barriers in Implementing LCC in Construction Industry

LCC Barriers	Authors
Client-related Factor	
Client is not aware of LCC and its benefits.	(Wan Hassan et al., 2014)
Client's lack of knowledge on LCC.	(Mohd Fairullazi & Khairuddin, 2011), (Lim et al., 2018)
Client did not request for LCC.	(Mohd Fairullazi & Khairuddin, 2011), (Kambanou, 2020)
Client's unwilling to pay more for LCC exercise.	(Chiurugwi et al., 2010), (Lim et al., 2018)
Client's unwilling to spend time on LCC exercise.	(Lim et al., 2018)
Client's reluctance to commit to a change in their management policy or strategy.	(Noor Azizah & Zainal Abidin, 2012)
LCC exercise is not compatible with client's intangible or non-financial objectives and needs.	(Chiurugwi et al., 2010)
Professionals-related Factor	
Professionals' lack of knowledge on the concept of LCC.	(De Giacomo, 2018)
Professionals' lack of knowledge on how to prepare LCC calculations.	(Oduyemi et al., 2014)
Professionals' lack of skill in LCC calculations.	(De Giacomo, 2018)
Lack of understanding of methodological problems and limitations.	(Cole & Sterner, 2000)
Lack of support and commitment among professionals.	(Lim et al., 2018)
Scarcity of resources such as LCC software.	(De Giacomo, 2018), (Kambanou, 2020)
Government-related Factor	
Government's & institution's lack of incentives to encourage clients to do LCC exercise.	(Chiurugwi et al., 2010), (Wan Hassan et al., 2014), (De Giacomo, 2018)
Government's lack of initiatives to help improve the adoption of LCC.	(Lim et al., 2018)
Lack of guidelines to assists understanding on how LCC calculations are done.	(Wan Hassan et al., 2014)
Lack of training on the standardized LCC approaches and guidelines.	(Lim et al., 2018), (Kambanou, 2020)
Data-related Factor	
Lack of reliable data to support LCC.	(De Giacomo, 2018), (Kambanou, 2020)
Lack of sufficient and reliable information at the early design stage to perform a proper LCC analysis.	(Higham et al., 2015), (Lim et al., 2018)
Lack of framework for collecting & sorting data.	(Kishk et al., 2003)
LCC-related Factor	
Contradictions between practices of design, cost calculations & data.	(Khiyon & Mohamed, 2018)
Restrictions on the sort of environmental and cost impacts.	(Lim et al., 2018)
Uncertainty regarding the benefits linked to LCC.	(De Giacomo, 2018)
Results from LCC analysis are difficult to interpret & not directly useful.	(Chiurugwi et al., 2010)
Project-related Factor	
Lack of time to carry out LCC during the early design and procurement stage.	(Chiurugwi et al., 2010), (Lim et al., 2018)
Lack of procurement and contract award incentives to use LCC.	(Chiurugwi et al., 2010)
Separation of capital/acquisition and running costs of most projects.	(Chiurugwi et al., 2010)
Different requirements of various green certifications.	(Lim et al., 2018)

It was found that no specific research has documented the main barriers in implementing LCC in Green construction projects. Hence, barriers to LCC implementation in construction industry derived from various literatures were used as the basis to identify barriers faced by the Malaysian construction industry in implementing LCC in green construction projects. Such data will provide necessary comprehension on why LCC is still limitedly applied in the country's development of green projects, as well as contributing to the existing theory on LCC barriers. Eventually, based on the findings, the research aims to devise more effective strategies to encourage LCC's use in the construction industry, specifically in green construction projects.

RESEARCH METHODOLOGY

This study is part of a research aimed to formulate a framework for LCC in green construction projects. A systematic literature review on the barriers to LCC implementation was carried out first to achieve the study's objective, which is to identify the possible barriers in implementing LCC in green building construction project. The review process additionally provided a better comprehension on the process of carrying out LCC in the construction industry. A total of twenty-eight (28) barriers were identified from the review and used to develop a set of questionnaires for the purpose of identifying the barriers in implementing LCC in green construction projects. The barriers identified from the literature were grouped into six (6) main barriers based on the nature of the barriers, whether they are related or due to Client-related factors, Professionals-related factors, Government-related factors, Data-related factors, LCC-related factors or Project-related factors. The purpose of grouping these barriers is so that it would be easier for the respondents to relate and understand the possible barriers since it is presented in a more organized format. Likert Scale of 1 to 5 ranging from 'not critical' to 'extremely critical' was used to evaluate the respondent's opinion on the barriers provided. The survey was then distributed amongst construction professionals, namely architects, quantity surveyors, engineers and other professionals that have experience in green construction projects.

Table 2. Respondents Rate

Types of Respondents	Number of Questionnaires		Response Rate (%)
	Distributed	Returned	
Architect	200	42	21
Quantity Surveyor	200	86	43
Engineer	200	31	15.5
Others	100	28	28
Total	700	187	26.7

The close-ended questionnaire was first distributed via traditional mail which has been proven a successful method and is representative of the population (Szolnoki & Hoffmann, 2013). However, due to the current COVID-19 pandemic, responses were very low. Therefore, to increase the response rate, the questionnaire was then reproduced using google form and distributed via e-mail and other online platforms, which are known for its speedier response and lower cost (Narak & Narayan, 2019). Furthermore, survey feedback and reminders were sent to facilitate response and ensure higher response rate. From a total of seven hundred (700) respondents, a total of one hundred and eighty-seven (187) completed and usable questionnaires were collected. Table 2 shows the highest response rate is from

quantity surveyors with 43%, followed by project managers, green consultants, and certifiers categorised as 'others' with 28%. While both response rates from architects and engineers were only 21% and 15.5% respectively. The overall response rate is 26.7% which is acceptable.

The data were then analysed by using frequency descriptive analysis and by mean values adopting IBM SPSS Statistic 26.

RESULTS

From the twenty-eight (28) barriers identified from the literature review, respondents were required to rate the criticalness of each barrier based on a 5-point Likert scale and were then ranked according to their relative criticalness, which are based on the mean score. The results tabulated in Table 3 shows the mean values and ranking based on the overall total of barriers.

Table 3. Overall Ranking on LCC Barriers

LCC Barriers	Mean	Rank
Client's unwilling to pay more for LCC exercise	*3.88*	*1*
Lack of guidelines to assists understanding on how LCC calculations are done	*3.76*	*2*
Client's reluctance to commit to a change in their management policy or strategy	*3.72*	*3*
Government's lack of initiatives to help improve the adoption of LCC	*3.56*	*4*
Client's unwilling to spend time on LCC exercise	*3.54*	*5*
Government's & institution's lack of incentives to encourage clients to do LCC exercise	*3.52*	*6*
Lack of procurement and contract award incentives to use LCC	*3.52*	*6*
Lack of training on the standardized LCC approaches and guidelines	*3.50*	*7*
Separation of capital/acquisition and running costs of most projects	*3.50*	*7*
Lack of reliable data to support LCC	*3.50*	*7*
LCC exercise is not compatible with client's intangible or non-financial objectives and needs	*3.48*	*8*
Client's lack of knowledge on LCC	*3.46*	*9*
Scarcity of resources such as LCC software	*3.44*	*10*
Client did not request for LCC	*3.40*	*11*
Different requirements of various green certifications	*3.40*	*11*
Client is not aware of LCC and its benefits	*3.38*	*12*
Contradictions between practices of design, cost calculations and data	*3.38*	*12*
Lack of time to carry out LCC during the early design and procurement stage	*3.38*	*12*
Lack of framework for collecting & sorting data	*3.34*	*13*
Professionals' lack of knowledge on how to prepare LCC calculations	*3.32*	*14*
Lack of sufficient and reliable information at the early design stage to perform a proper LCC analysis	*3.30*	*15*
Lack of support and commitment among professionals	*3.28*	*16*
Restrictions on the sort of environmental and cost impacts	*3.22*	*17*
Professionals' lack of knowledge on the concept of LCC	*3.18*	*18*
Lack of understanding of methodological problems and limitations	*3.18*	*18*
Professionals' lack of skill in LCC calculations	*3.14*	*19*
Uncertainty regarding the benefits linked to LCC	*3.14*	*19*
Results from LCC analysis are difficult to interpret and not directly useful	*3.10*	*20*

DISCUSSION

As mentioned earlier, the barriers were categorized into six (6) group factors. For discussion purposes, Table 4 to 9 shows the relative ranking of the barriers inside each group factor. The rankings inside each of the mentioned tables were achieved based on the overall rankings tabulated earlier in Table 3. Table 4 shows the LCC barriers related to client factor, where 'Client's unwilling to pay more for LCC exercise' is ranked first with a mean score of 3.88, followed by 'Client's reluctance to commit to a change in their management policy or strategy' with a mean score of 3.72 and 'Client's unwilling to spend time on LCC exercise' with a mean score of 3.54. In the overall ranking (Table 3), all three (3) barriers were ranked within the top five (5) spot. This suggests that barriers due to client factor are the main barriers faced in implementing LCC in green construction projects, however all three barriers are only at critical level.

Table 4. LCC Barriers Due to Client-Related Factor

LCC Barriers - Client Factor	Rank
Client's unwilling to pay more for LCC exercise	*1*
Client's reluctance to commit to a change in their management policy or strategy	*2*
Client's unwilling to spend time on LCC exercise	*3*
LCC exercise is not compatible with client's intangible or non-financial objectives and needs	*4*
Client's lack of knowledge on LCC	*5*
Client did not request for LCC	*6*
Client is not aware of LCC and its benefits	*7*

Table 5 presents the LCC barriers relevant to professionals' factor. Under this category, 'Scarcity of resources such as LCC software' is ranked at number one spot with a mean score of 3.44, while ranked at second and third place is 'Professionals' lack of knowledge on how to prepare LCC calculations' (mean score of 3.32) and 'Lack of support and commitment among professionals' (mean score of 3.28). All three barriers were rated 'critical' but did not fall within top ten position of the overall ranking (Table 3) except for 'Scarcity of resources such as LCC software'. The other barriers under this category were in overall rated as 'critical' but positioned at bottom three of the overall ranking.

Table 5. LCC Barriers Due to Professionals-Related Factor

LCC Barriers - Professionals Factor	Rank
Scarcity of resources such as LCC software	*1*
Professionals' lack of knowledge on how to prepare LCC calculations	*2*
Lack of support and commitment among professionals	*3*
Professionals' lack of knowledge on the concept of LCC	*4*
Lack of understanding of methodological problems and limitations	*5*
Professionals' lack of skill in LCC calculations	*6*

Table 6 shows the LCC barriers due to government factor, where 'Lack of guidelines to assists understanding on how LCC calculations are done' is ranked at first place, followed by 'Government's lack of initiatives to help improve the adoption of LCC'. In the overall ranking tabulated in Table 4, both barriers were ranked at second (mean score 3.76) and fourth place (mean score 3.56) respectively. While the remaining two (2) barriers under this category ranked sixth and seventh place in the overall ranking. This indicate that barriers under this category are among the main barriers faced in implementing LCC in green construction projects, however all are only at critical level.

Table 6. LCC Barriers Due to Government Factor

LCC Barriers - Government Factor	Rank
Lack of guidelines to assists understanding on how LCC calculations are done	*1*
Government's lack of initiatives to help improve the adoption of LCC	*2*
Government's & institution's lack of incentives to encourage clients to do LCC exercise	*3*
Lack of training on the standardized LCC approaches and guidelines	*4*

Table 7 indicates the LCC barriers relevant to data factor, where 'Lack of reliable data to support LCC' is ranked at first place, followed by 'Lack of framework for collecting & sorting data' and 'Lack of sufficient and reliable information at the early design stage to perform a proper LCC analysis'. In the overall ranking tabulated in Table 3, these barriers were ranked at seventh, thirteen and fifteen place with each having a mean score of 3.50, 3.34 and 3.30 respectively. This indicates that barriers under this category are less significant in hindering the implementation of LCC in green construction projects.

Table 7. LCC Barriers Due to Data-Related Factor

LCC Barriers - Data Factor	Rank
Lack of reliable data to support LCC	1
Lack of framework for collecting & sorting data	2
Lack of sufficient and reliable information at the early design stage to perform a proper LCC analysis	3

Shown in Table 8 are the LCC barriers that are relevant to LCC factor. In this category, 'Contradictions between practices of design, cost calculations and data' is ranked at first place, while in the overall ranking tabulated in Table 4, this barrier is ranked at twelve spots with a mean score of 3.38. The other three (3) barriers under this category ranked at the bottom level of the overall ranking with mean scores of 3.22, 3.14 and 3.10 respectively, suggesting that these barriers are least critical compared to the others, although all are rated as 'critical'.

Table 8. LCC Barriers Due to LCC-Related Factor

LCC Barriers - LCC Factor	Rank
Contradictions between practices of design, cost calculations and data	*1*
Restrictions on the sort of environmental and cost impacts	*2*
Uncertainty regarding the benefits linked to LCC	*3*
Results from LCC analysis are difficult to interpret and not directly useful	*4*

The final category of LCC barriers is those contributed by project factor. Table 9 indicates the top rank position as 'Lack of procurement and contract award incentives to use LCC', followed by 'Separation of capital/acquisition and running costs of most projects' at the second spot. These barriers ranked at sixth and seventh position in the overall ranking (Table 3), having a mean score of 3.52 ad 3.50, respectively. While the other two (2) barriers ranked at eleventh and twelfth position in the overall ranking (Table 3) with a mean score at critical level, of 3.40 and 3.38 respectively.

Table 9. LCC Barriers Due to Project-Related Factor

LCC Barriers - Project Factor	Rank
Lack of procurement and contract award incentives to use LCC	*1*
Separation of capital/acquisition and running costs of most projects	*2*
Different requirements of various green certifications	*3*
Lack of time to carry out LCC during the early design and procurement stage	*4*

Table 3 shows the overall ranking of the LCC barriers. The top 10 barriers had a mean score between 3.50 to 3.88. The barriers ranked first with a mean score of 3.88 was 'Client's unwilling to pay more for LCC exercise', while 'Lack of guidelines to assists understanding on how LCC calculations are done' ranked second with a mean score of 3.76. 'Client's reluctance to commit to a change in their management policy or strategy' ranked third with a mean score of 3.72, followed by 'Government's lack of initiatives to help improve the adoption of LCC' in fourth spot (mean score of 3.56) and 'Client's unwilling to spend time on LCC exercise' in fifth spot (mean score of 3.54). Barriers ranked in sixth spot with a mean score of 3.52 were a tie between 'Government's & institution's lack of incentives to encourage clients to do LCC exercise' and 'Lack of procurement and contract award incentives to use LCC'. And with a mean score of 3.50, three (3) barriers; 'Lack of training on the standardized LCC approaches and guidelines'; 'Separation of capital/acquisition and running costs of most projects'; and 'Lack of reliable data to support LCC' ranked seventh. While the rest of the barriers had mean scores between 3.10 to 3.48.

The findings revealed that all barriers surveyed were rated between critical to very critical level. However, barriers associated with client factor and government factor are the main hindrance to the implementation of LCC in green construction projects. Three of the top five (5) position of the overall ranking were dominated by barriers under the client factor, which are 'Client's unwilling to pay more for LCC exercise', 'Client's reluctance to commit to a change in their management policy or strategy' and 'Client's unwilling to spend time on LCC exercise'. Such discovery supports the claim made by Lim et al (2018) that some clients are reluctant to request for LCC as well as unwilling to pay more and spend time on LCC exercise (Lim et al, 2018). The claim was made because of their findings that the clients other than the architects, are the key culprits that hinders the implementation of LCC. This is said to be due to the fact that they place greater emphasis on initial costs and design over strategic value of an asset.

Apart from that, the analysis shows 'Lack of guidelines to assists understanding on how LCC calculations are done', 'Government's lack of initiatives to help improve the adoption of LCC' and 'Government's & institution's lack of incentives to encourage clients to do LCC exercise' were ranked at second, fourth and sixth of the overall ranking, which are all barriers from the government factor category. This does not mean that the government is not promoting LCC as a supporting decision tool for the evaluation of matters relevant to sustainable and green development. Many initiatives have been taken by governments around the world in the effort of encouraging the application of LCC in the industry (Chiurugwi et al, 2010). Nonetheless, the government should play a more active role in addressing these barriers. As revealed in a study done in the UK construction industry by Oduyemi et al (2014), one of the key factors that prevented wider application of LCC was the absence of standardized guideline, which echoes the finding of this study. A couple of years later, UK's RICS professional guidance on LCC were published (RICS, 2016) perhaps in response to this finding. Same should be taken up by the relevant government bodies and institution in Malaysia perhaps to come up with a much detail and clearer LCC guideline, or even a dedicated framework on LCC process for green construction projects, as suggested earlier. Furthermore, planning and executing more initiatives and incentives to encourage the implementation of LCC in green construction projects.

Other barriers with a mean score of 3.50 and above were 'Lack of procurement and contract award incentives to use LCC' ranked at sixth place, 'Separation of capital/acquisition and running costs of most projects' and 'Lack of reliable data to support LCC', both ranked at seventh place. As discovered in a local study by (Khiyon & Mohamed, 2018), lack of motivation is among the top barriers for LCC in PPP/PFI projects. The lack of incentives for LCC to be carried out when procuring for the project as well as separation of project cost and operation cost, appears to be project-related factors. Perhaps if LCC exercise gives an added advantage in tender evaluation or even becomes part of the project's objectives, this encourages contractors to include LCC when putting forward their offer or proposal. Hence clients are able to assess the most economical offer and anticipate potential savings in future operation and maintenance cost of the project at an early stage (Heralova, 2017). Whereas the lack of reliable data for LCC can be considered as data-related factor. This stems from the fact that LCC is a cost prediction tool, where immense amount of data is required, parameters and assumptions must be made when carrying out the LCC (Khiyon & Mohamed, 2018). Establishing a standardized LCC approaches and guidelines for green construction project possibly may help to address this barrier.

CONCLUSION

As a conclusion, it can be summarized that the main barriers in implementing LCC in green construction projects are mostly related or due to project clients and the government. The clients and government need to move away from the conventional practice when it comes to green project development, specifically in favouring short term initial costs instead of the best long-term costs and benefits. More need to be done by the industry to enhance LCC practices in green construction projects. Clients as the decision makers should be the drivers to encourage the LCC use. Besides, the government and its relevant bodies should formulate more effective strategies to promote LCC, specifically in green construction projects. Formulation of LCC framework or guideline specifically designed to suite green projects perhaps would overcome the barriers, thus encourage its application. The findings of this study are beneficial to industry players of green developments as a reference to enhance the LCC process and to devise more effective strategies to promote acceptance of LCC in Malaysia's green construction projects which will ultimately contribute positively towards achieving the world's green construction agenda. For future research, it is recommended to focus on investigating project clients' perception or awareness on the benefits of implementing LCC in green construction projects.

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SAFE CITY INITIATIVES (SCI) AMONG LOCAL AUTHORITIES IN SELANGOR

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Abstract
Safe City is being in the pipeline for more than 20 years since it was first launched in 2004. This paper aims to provide an initial point of reference on safe city initiatives implemented by the Malaysian local authorities. Parallel to the safe city program, 15 initiatives were generated within the three (3) main key Strategy of Environmental Design initiatives, Target Hardening initiatives and Management Community Involvement, and Public Awareness. Five (5) local authorities' representative the city council level, municipal level, and district level of 5 different zone in Selangor. The objectives are to identify the most significant initiatives implemented that was highly in demand among Local Authorities (LA) and to determine the most prominent category apply to the selective of LA toward the safe city program. A qualitative methodology using semi-structured interviews was conducted. The aim of this paper is to identify the Safe City initiatives implemented and the most prominent initiatives conducted by the selected Local Authorities in Selangor. The finding indicates that only eight (8) initiatives were commonly implemented by the (LA) in Selangor from 15 initiatives mentioned which led to objective one. The second strategy of Target Hardening captured the most prominent initiatives implemented using five (5) initiatives from the eight (8) most common initiatives used in Selangor to address objective two. It consists of safety mirror, crime prevention signage, motorcycle parking with locking facilities, CCTV installation and lighting. Since only five (5) initiatives consistently implemented, it shows the implementation of safe city initiatives is moderate and only focus by the Central LA of Selangor. An extensive exploration on the modification initiative needs to be conducted to ensure the mission in cultivating conducive and secured environment can be obtained.

Keywords: *Safe city; Local Authority; initiatives.*

INTRODUCTION

United Nations (UN) predictions, the world population will reach nearly 10 billion by 2050 compared to the present 7.5 billion (UN, 2019). It leads to a comprehensive overview of global demographic patterns and prospects. The Safe City concept is one approach focusing on the crime problem in urban areas (Anuar et al., 2012). The crime rate was used as the indicator of a safe city besides other indicators such as political, economic, physical, social, and others. Crime is an issue that is gaining attention from a society that has forced the Malaysian Government to put efforts into the implement Safe City Program by Ministry of Housing and Local Government (Malaysia). It was enforced by Town and Country Planning Department, Malaysia in 2004 which involved more than 38 PBT or known as Local Authority to fully commit to the program (Shuhana S. et al., 2013). The number increased to 149 local authorities committed reported on 2014 (Yong, 2019). Although Shah Alam City Council has declared being the first Local Authorities (LA) committed fully toward Safe City,

the question arises, to what extent do Local Authorities work toward the implementation of Safe City? The aim of the paper is to identify the critical initiatives of Safe City implementation based on the Safe City Program for certified local authorities in Selangor. This study will embark on the critical prominent strategies for delivering the Safe City initiatives. A set of questions and inventory among five (5) local authorities at the council level, municipal level, and district level was selected in the state of Selangor.

BACKGROUND STUDY

Safety is a central dimension of contemporary debate on urban sustainable development. It is defined as to achieve safety condition of being safe from risk or danger and to ensure protection of society, property, environment and physical without depending entirely on the intelligent technologies (Ristvej, 2020). However, the integration of technology and natural environment increases the effectiveness allow its citizens life in a healthy environment as well as to achieve a readiness and quick response to threatening or arose emergencies (Lacinák, 2017).

This can be achieved by combining security systems into a single information space based on the cloud paradigm (Raj et al., 2015) or better known as a unified plan of response to major crises (Fedorov, 2012). It allows the citizens to live in a healthy environment. Increasing the inclusiveness in urban area by creating equal and wider chances for participation of all parties to keep the public space lively to increase safety in urban spaces (Farr & Piroozfar, 2013) as highly populated cities will no longer have the comfort features to protect the well-being of urban society (Hussain et al., 2018). For that reason, further adaptations according to the market and regulatory is needed to accomplish the Safe City approach (Vitalij et al., 2013).

Local Authorities (LA) are subjected to the jurisdiction of State Government respectively where the term and reference in the Ministry of Housing and Local Government is to coordinate policies, law standardization, provision of advisory services including technical and reimbursement allocation from Federal Government. There are currently 153 local authorities (including Kuala Lumpur City Hall), consisting of 17 City Hall/Council, 39 Municipal Council, 94 District Council and 5 special or modification local council. The category of Local Authorities in Malaysia been classified based on the total capacity of population and annual revenue.

Substantial policy, guidelines and reports produced in the international and local context have stressed local authorities has been recognised as the most important authority in establishing numerous city development policies. The process of efficient and strategic positioning of urban project and services, agreement and assistance of local people is needed and it cannot be taken for granted (Braun, 2013). It agreed by Cho and J (2017) as it lead to basic human desires and eventually push the local government's policies toward safety. A clear image of the city can generate good feeling of comfortable, secured and emotionally through positive involvement among residents. This will result a positive attitude and commitment for city management and their future work. City managers should seek to establish closer links between residents and the city for their successful long-term relationship (Belanche et al., 2016).

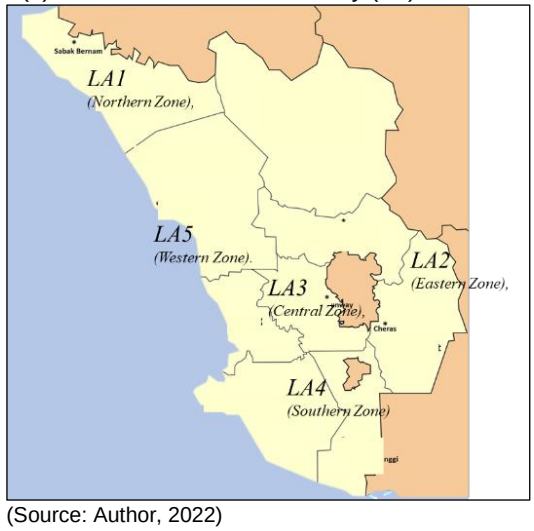
PROBLEM STATEMENT

In Malaysia, the concept of Safe City was launched in 2004 by the Ministry of Housing and Local Government (Malaysia). There are four (4) basic missions to be achieve which are free from violence, destruction and disasters, social and moral decay as well as incidents. Safe city program was developed using 23 steps initially which more emphasis on physical crime prevention (Zainudin, 2010). In 2005, the National Council for Local Government endorsed this programme and instructed all 38 local authorities (city and municipal councils) in Peninsular Malaysia to participate in this programme. In the year 2009, the Safe City Programme was revised and formally listed under the National Key Result Areas (NKRAs) to create awareness on public safety issues related to crime and policing (Yong, 2019). The safe city programme is using crime prevention through environmental design (CPTED) using 3 specific strategies of Environmental design initiatives, Target Hardening and Management, community involvement and public awareness address to specific initiatives. After more than 15 years of its launched, the issues arise to what extend was the implementation of safe city was conducted among the LA focussing in Selangor area. It is the reason that drives the two mains of objectives of this study and eventually brought a significance contribution on the level of security within the area of control.

METHODOLOGY

This study employs a qualitative method using semi-structured interview. The purpose for this interview is to get the in-depth data from the interviewee. The level of spontaneous able to sustain continuously and allow the interviewee to maximize the opportunity give to address the research topic (Mack et al., 2005). A series of open-ended questions was delicately asked during the session, with accompanying queries that probe for more detailed and contextual data. The method was used to identify the possibility implementation initiatives and factors influencing the barriers of delivery among the local authorities selected. The interview session was employed for the purpose to understand and analyse in the detail from the perspective from the local authority's representatives. Five (5) specific senior officers were selected in this interview session.

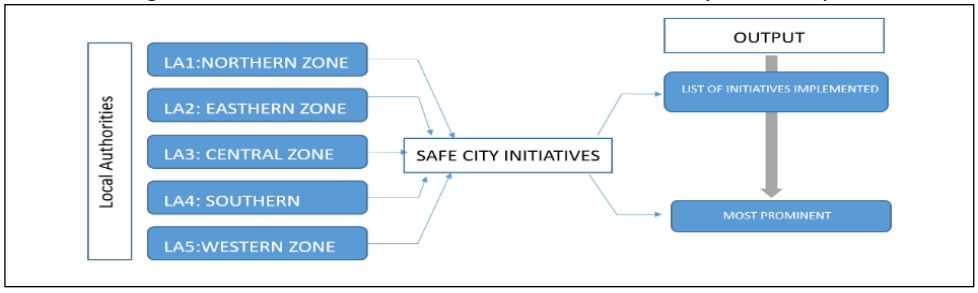
Figure 1. The Five (5) Zones of The Local Authority (LA) Within the State of Selangor



(Source: Author, 2022)

Five (5) Local Authorities (LA) was selected within the state of Selangor. There are two (2) district council, two (2) municipal council and one (1) city council which covered all three (3) level of local authorities' enforcement as stated on Figure 1. All the interviewee consists of minimum 10 year working experience within the field of study and involved directly on the implementation of Safe City to ensure the reliability of the content. All Local Authorities (LA) selected was located within the state of Selangor. To avoid confusion, the respondents on the respective local authorities were categorize in zone such as Local Authority LA1 (Northern Zone), LA2 (Eastern Zone), LA3 (Central Zone), LA4 (Southern Zone) and LA5 (Western Zone). Interviewee' answers provide rich, in-depth information that helps the researcher to understand the process involved on safe city implementation. The interview questions were drafted with the objective of getting the current issues, barriers, problems behind any selection of initiative conducted toward achieving the mission of safe city approach. Such an approach produces a considerable amount of textual data for analysis (Abowitz & Toole, 2010) Figure 2 stated the Flowchart of Data Collection Process.

Figure 2. Flowchart of Data Collection Process and Expected Output



(Source: Author, 2022)

RESULT AND DISCUSSION

Five (5) Local Authorities (LA) was selected within the state of Selangor. There are two (2) district council, two (2) municipal council and one (1) city council which covered all three (3) level of local authorities' enforcement. Each Local Authorities (LA) represent five (5) different zones such as local authority LA1 (Northern Zone), LA2 (Eastern Zone), LA3 (Central Zone), LA4 (Southern Zone) and LA5 (Western Zone). Every Local Authorities (LA) was mapped according based on the three (3) main Strategy of Environmental Design initiatives, Target Hardening initiatives and Management Community Involvement, and Public Awareness within the 15 initiatives.

Table 1. Determined The Critical Initiatives of Safe City Implementation by Local Authorities

KEY		INITIATIVES	ALTERNATIVE	LA1	LA2	LA3	LA4	LA5	RANK
Strategy 1 Environmental design initiatives	SCI1	Separation of pedestrian walkways from motorised lanes	Provision of dedicated walkways	√	√	√	√	√	1
			Provision of bollards	√	√	√	√	√	
			Provision of railing	√	√	√	√	√	
			Provision of landscaping	√	√	√	√	√	
	SCI2	Implements Crime Prevention Through Environmental Design (CPTED)	self-initiatives by the council			√	√		2
			initiatives by the developers	√	√	√	√	√	
			effort from the community	√	√	√	√		
	SCI3	Establishment of GIS mapping for crime and safe city programme	self-initiatives by the council			√			3
			data captured from police department	√	√	√	√	√	
Strategy 2 Target Hardening	SCI4	Police presence	mobile / patrol	√	√	√	√	√	3
			station		√	√	√		
	SCI5	Safety mirrors	blind spot	√	√	√	√	√	1
	SCI6	Crime prevention signage	located at the entrance of the community	√	√	√	√	√	1
	SCI7	Safety alarms (panic button)							4
	SCI8	Motorcycle parking with locking facilities	sheltered area	√	√	√	√	√	1
			opened area	√	√	√	√	√	
	SCI9	Installation of CCTV in commercial premises and public places	one way communication	√	√	√	√	√	1
			two-way communication			√	√		
	SCI10	Lighting	normal lighting	√	√	√	√	√	1
			LED lighting			√		√	
	SCI11	Unobstructed view of public walkways	limitation height of vegetation	√		√		√	2
			eliminated of blind spot		√	√	√		
	SCI12	Generate appropriate activities at vulnerable crime spots	economic resources			√			3
			community activities area		√	√	√		
Strategy 3 Management, community involvement and public awareness	SCI13	Education, public awareness and publicity	poster / banner related mission delivery	√	√	√	√	√	2
			competition	√				√	
			reward grant to community	√	√	√	√	√	
			public campaign	√	√	√	√	√	
	SCI14	Public involvement in planning and implementation of Safe City programme	the existence of Ahli Majlis in the organization structure	√	√	√	√	√	1
			registered residence association	√	√	√	√	√	
			dialogue session	√	√	√	√	√	
	SCI15	Fixed agenda on Safe City Programme at full council meeting	quarterly	√				√	3
			every 6 months		√	√	√		
			random						

Analysis of The Initiative of Safe City Implementation

Implementation of Strategy 1: Environmental Design Initiatives

From the finding, there are two (2) initiatives from the first group of strategy 1 which are separation of pedestrian walkways from motorised lanes and Crime Prevention Through Environmental Design (CPTED) implementation. From the interview session, separation of pedestrian walkways is more prominent compared to Crime Prevention Through Environmental Design (CPTED) implementation was equally implemented by all the district, municipal and city council. Although it focussed specifically on the main road of the community area due to space constraint and the width limitation, landscaping or railing are used to segregate the two spaces. Whilst the implementation of CPTED was a part of Safe City initiatives that was clearly address on Local Agenda 21 Committee (LA21) and only applied on the new development approval submission of safe city requirements. Based on LA1 and LA5 it depends on the developer's proposal to fulfil the safe city requirements. Gated & Guarded Communities (G&G) was commonly applied on strata development schemes. The needs and trends also applied on existing residential communities. Currently 85% of public voting is needed and compulsory for submission approval purposes. Due to agriculture of land status and community network among residents made G&G system not in demand on Northern LA1 area.

LA3 is the only local authority having a prototype toward safe city initiative located on specific commercial area with several numbers of CCTV that is fully monitored by the LA and police department. The mission is to control the illegal parking area, to observed hot spot area and eliminate the existence of illegal hawkers. LA4 has done an impressive effort in producing a documented illustration to enhance the understanding of safe city implementation on new development among developers, contractors, builders and other related field.

Implementation of Strategy 2: Target Hardening

Referring to the finding, there are nine (9) initiatives conducted on strategy 2. The highly implemented was safety mirror, crime prevention signage, motorcycle parking with locking facilities, installation of CCTV and lighting. These are five (5) initiatives commonly conducted due to effective approach to minimize the crime rate in the community area. All respondents agreed Crime prevention signage is most cost effective in order to provide first stage of information during emergency. Allocated at the main entrance within the range of visibility in the community area has brought positive impact to the residents with minimal cost of maintenance. This was well practiced especially in Central, Southern, Eastern, Western and Northern LA.

Safety mirror is critically required to avoid blind spot focussing on the back lane of a commercial area. Motorcycle parking with locking facilities, installation of CCTV on specific spot-on public access road. The allocation of the CCTV was captured and reported every 6 months from police department for further action taken by the respective LA. Although cost and maintenance experience by LA1, LA2 and LA5 the information gain is crucial. The system proof to provide a significance impact to the minimize the crime rate. It is a concept and solution offer in providing information and communication services, into a single information space.

LED lighting was highly used among LA focussing on the main road of the community area. It is one of the alternatives done to minimize any incident on darkness area which prompt towards crime. Unobstructed view of public walkways was not critically considered at district level of LA1 and LA5. Less density, high ownership and self-belonging make those initiative less applicable. However, the initiatives were critical on the municipal council and city council level. It is due to the number of populations, resident's background, the density pattern, building layout and lifestyle of the community make the initiatives more practical on LA2, LA3 and LA4. All the LA mentioned safety alarms (panic button) applied on individual properties at this point of time.

Implementation of Strategy 3: Management, Community Involvement and Public Awareness

Based on the findings all five (5) respondents indicate, educating to the public in proving awareness is a part of publicity and highly implemented to ensure the delivery of information able to be capture among the community. The various strategies were implemented depending on the culture, and the acceptance level of the people. Dialogue session periodically was used for LA1 and LA3 to capture the current community issues with the help of high committed resident association. LA1, LA2 and LA5 also practice one off funded in the form of monetary grant to the communities through competition or project proposal submission related toward safe city initiatives.

In fact, project competition was done by LA5 on yearly basis and highly in demand. Only registered resident's association entitle for the activities conducted by LA. In fact, LA2 and LA4 did collaborate with school student to inculcate positive vibes from the younger group in the community. Furthermore, public involvement in planning and implementation of Safe City programme has been implemented by having the Councillors (Ahli Majlis) representing the various zone within local authorities' operation area. It was mentioned by Anholt (2007), the perception of the residents should be highlighted as capacity of being the living ambassadors of their city once they feel connected affectively with the city. However, the fixed agenda on Safe City Programme at full council meeting is manageable at the district level compared to municipal and city level as stated by R1. The rate of conducting meeting is highly practiced might be due to the residents' culture and living style at district level compared to LA2, LA3, LA4 and LA5 due to high populated area and different lifestyle practices.

Analysis of The Most Prominence Initiative of Safe City Implementation

The most prominent initiatives were address accordingly based on the five (5) different zones of Local Authority (LA). It was based on the three (3) main key category of Environmental Design initiatives, Target Hardening initiatives and Management Community Involvement, and Public Awareness within the 15 initiatives.

Based on fifteen (15) initiatives from the three (3) main key strategy, only eight (8) initiatives were commonly implemented on all the five (5) different zone of the Local Authority (LA). However, Strategy 2 of Target Hardening shown the most significantly initiatives implemented which covered the majority of five (5) initiatives compared to Strategy 1 and 3. The implementation of those initiatives was due to better segregation of

mechanism that can be placed accordingly based on the needs and priority make the monitoring approach more practical. It was agreed by Lim (2020) that divisional of crime level into a high-crime rate, medium-crime rate, low-crime rate is one of the approaches used.

Table 2. Shows The Most Prominent Safe City Initiatives in Practices Among the Local Authorities (LA)

KEY	INITIATIVES		LOCAL AUTHORITIES
Strategy 1 Environmental Design Initiatives	SCI1	Separation of pedestrian walkways from motorised lanes	LA1, LA2, LA3, LA4, LA5
Strategy 2 Target Hardening	SCI5	Safety mirrors	LA1, LA2, LA3, LA4, LA5
	SCI6	Crime prevention signage	LA1, LA2, LA3, LA4, LA5
	SCI8	Motorcycle parking with locking facilities	LA1, LA2, LA3, LA4, LA5
	SCI9	Installation of CCTV in commercial premises and public places	LA1, LA2, LA3, LA4, LA5
	SCI10	Lighting	LA1, LA2, LA3, LA4, LA5
Strategy 3 Management, Community Involvement and Public Awareness	SCI14	Public involvement in planning and implementation of Safe City programme	LA1, LA2, LA3, LA4, LA5

It was found that the Central-Local Authorities which under the city council has implemented more than 12 initiatives from the total of 15 initiatives of safe city program enforced by Town and Country Planning Department compared to the other local authorities. The combination of physical and mechanical existence when the Central Local Authority has push forward the civility of the community and eventually reflected to the decreasing rate of crime. Although those initiative regard to high installation and maintenance cost, due to fund allocation by the state government make the various initiative more possible.

It is followed by the Southern, Western and Eastern Local Authorities area at the moderate level of implementation as all of three (3) zones are within the municipal level. Although, Northern Local Authorities was far left behind others in terms of initiatives implemented it shows other indicator of insufficient needs of safety initiatives required in the area. The factors might influence due to less population rate, less density condition and high rate of local people occupancy which lead to high level of ownership as Northern Local Authority is still within the district level.

CONCLUSION

Based on the results, it shows the pattern of safe city implementation initiatives within the level of authority of city, municipal and district level. There is a significant gap between central and other local authorities due to various factors. Insufficient numbers of officers available in the organization, inadequate of consistent fund provided and less critical issues related to safety within the area influence the implementation of safe city initiatives conducted among Local Authorities. Although various effort has been placed accordingly, the mission in cultivating safe city environment need to be inculcate in producing a conducive and secured environment. Since very city faces different problems in different circumstances, the same solution will not bring the same results (Lacinák, 2019). This is considered as a new insight for all the stakeholders to comprehend and practice. However, this study has some limitations due to subjective views and could lead to biased; thus, further quantitative studies are recommended to test the syntheses formed in this study.

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SIGNIFICANT FACTORS INFLUENCING DELAY OF ISSUING PROJECT INFORMATION IN CIVIL ENGINEERING PROJECTS

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Abstract

Failure of the designer in providing necessary project information within the time frame disrupts the efficiency of the construction process and wastes contractor resources. It could lead to disputes and poor project performance if the problem is not properly controlled and managed. Despite the numbers of underperformance in terms of time in civil engineering projects increased recently, however, it has been neglected. Therefore, the aim of this paper is to determine the most significant factors influencing the delay in issuing project information to the contractor in civil engineering projects. The data was obtained in two stages from professional civil engineers and Grade G7 contractors that registered under their umbrella organisations. The first stage was identification of factors that cause a delay in providing project information in civil engineering projects via questionnaire survey, whereby in the second stage twenty-eight industry practitioners were interviewed to gain their deeper insight on this matter. Based on the result from questionnaire surveys and semi-structured interviews, this study determined that project scope changes, ground uncertainty, site surrounding uncertainty, adequacy of details and specifications of original design and competency of engineer were the five factors as being extremely high significant in influencing delay of issuing project information in civil engineering projects in Malaysia. These five factors if properly understood and put more concern by the client and engineer at the onset of every project may increase the ability of the engineer to respond within the time frame and reduce the severity occurrence of delay of issuing project information in future civil engineering projects. This study indicates construction industry practice areas that require improvement and also makes a significant theoretical contribution in a way of devising ways of combating delays and problems in construction projects.

Keywords: *Civil engineering; delay; project information; project characteristics.*

INTRODUCTION

Delays of providing project information such as documents, drawings, technical information and instructions is a prominent undesirable contractual behavior in the implementation of a construction project. This unfavorable incident has been reported in literature as among the factors triggering disputes among the project participants that lead to poor project performance (Zhang et al., 2016; Cheung et al., 2008; Charoenngam & Yeh, 1999). Zhang et al. (2016) and Krima et al. (2007) argued that late in giving instructions as well as late approval of drawings are among the factors that caused interruption to the regular progress of works on site. In fact, the delay of providing necessary information due to changes of the contract scope, late approval and supervision and the late agreement with the contractor on the variations works highly cause a reduction in the efficiency of the construction process (Atout, 2016). Eventually, lead to project time overruns.

Bakhary (2019) highlighted that the delays in providing the required project's detail plans, instructions and approvals are within the client/engineer's responsibility. Hence, the contractor would entitle to claim extension of time (EOT) and monetary reimbursement for the direct loss and expense suffered by him due to such delays. This entitlement is stated in PWD 203A SFoC (Clause 43f) and PWD DB SFoC (Clause 49.1e). Unfortunately, the responsibility to prove the occurrence of such delay by the engineer/client is cast on the contractor. Certainly, it is quite challenging for claiming an EOT and/or damages because the contractor has to provide written evidence to support the claim (Bakhary, 2019). The failure to provide adequate evidence that the critical path method (CPM) has suffered irrecoverable delays may cause the EOT application rejected. This unfair deal has caused dissatisfaction by the contractor and could lead to conflict between the contractor and the engineer/client which eventually affect performance of the project. Therefore, the underlying sources that contribute to the delay of issuing project information to the contractor are critical to be investigated to ensure good relationships among key participants while implementing construction project, thus ensure satisfactory project performance.

LITERATURE REVIEW

Problems of delay in issuing the project information are not frequently caused solely by the designer's fault but contributed by many sources during the course of the work. The answers of the reasons for the delays might be due to characteristics of the projects that cause frequent changes of design during implementations, lack of experience of designers in design management and resources, bureaucracy practices in the government agencies and lack of the project contract and governance (Marique, 2013; Sadek, 2016; Ismail et al., 2020). Since the project stakeholders are still suffering from the impact of unpleasant project performance in spite of the adoption of novel techniques of design and project management, determining and identifying the root causes of the delay in providing project information to the contractor during the construction stage is vital to ensure smooth project implementation.

Factors Influencing Delay of Issuing Project Information

The civil engineering project characteristics are complex in design and involve many participants in its implementation. Frequently, there are many unpredictable situations can occur during construction works that can cause change orders, claims and disagreements (Guo et al., 2016). Due to the uncertainty in the implementation stage, the project scope is impossible to be fully defined where most of the time the design might be changed along the way the construction implementation. The changes of the project scope once the construction has been implemented on site significantly causes to the delay of providing project information because many revisions and amendment to be made on the original design. Meanwhile, at the project definition stage, very often not all information is complete. Frequently, the decision makers make decisions based on available information surrounding them that may be insufficient for the whole implementation of the project. For instance, in the determination of the project scope, the design and the type of procurement method used. Hence, changes are unavoidable because of the uncertainty conditions in which construction projects operate and the failure of designers to foresee and provide for all possible eventualities. Winch (2002) claimed that the fewer information available at the inception stage, the higher the level of risk and uncertainties of the project. Therefore, the availability of design information is directly affecting the completeness of design before work started on

site. Eventually, causes a delay in issuing project information to the contractor.

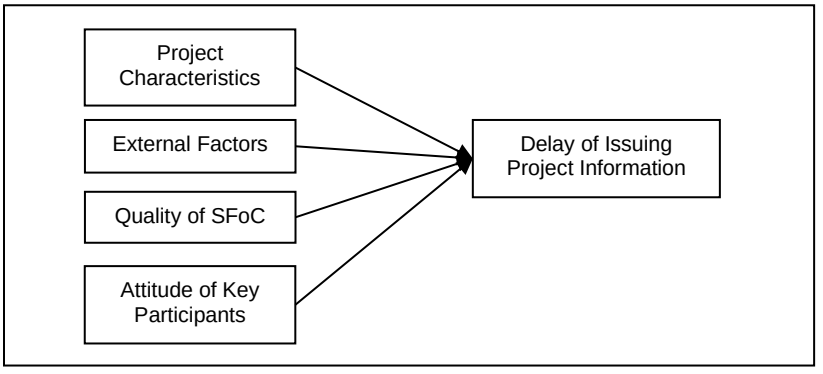

Figure 1. Conceptual Framework of The Study

Other than project characteristics, external factors such as weather condition (Yong & Mustaffa, 2012; Sambasivan & Soon, 2007; Iyer & Jha, 2005) resources availability (Iyer & Jha, 2005; Jaffar et al., 2011; Yu & Shen, 2013) technological advancement (Songer & Molenaar, 1997) changes of government laws and regulations (Shehu et al., 2014) and government bureaucracy (Shehu et al., 2014; Ahmed & Othman, 2013) are the other important factors that could also contribute to the delay. Therefore, it is important to verify statistically whether these factors do give impacts on the delay of issuing project information to contractors in civil engineering projects. Meanwhile, the key participant's individual attitude factors like poor in complying the condition of contract (Shehu et al., 2014), poor in understanding the content of contract (Shehu et al., 2014) opportunistic behaviour (Alkhamali et al., 2010), commitment to achieve project goal, cooperation in solving problems (Nachatar et al., 2003; Iyer & Jha, 2005) and competency of contractor and engineer (Shehu et al., 2014; Ahmed & Othman, 2013; Gosling et al., 2013) also causes timely issuance of project information impossible to be made. Thus, the attitude of the project participants in implementing their tasks in the projects could be unpredictable and impact significantly on the delay of issuing project information.

In addition, since the relationship of the project participants in a construction project are temporary and will dissolve once the project completed, the standard form of contracts is more desirable to a specially drafted contract. This type of contract is ready-to-use and more comprehensive for most construction projects, hence capable to reduce the cost and time of negotiating contracts (Chan, 1993). Nevertheless, there are various issues regarding on the quality of the SFoC mentioned in the literature that related to clarity, completeness and fairness of the SFoC (Rameezdeen & Rodrigo, 2010; Ali & Wilkinson, 2010; Chong & Zin, 2010; Wright & Fergusson, 2009; Cheung et al., 2006). These deficiencies may cause the SFoC fail to respond to complexity and unpredictable site and ground condition, hence prolongs the process of issuing project information. Therefore, a good contract capable to improve the level of communication among the project participants, ensuring the smooth functioning of a project and facilitating a process that allows the project participants to achieve superior performance. Under the four aforementioned domain, there were twenty-seven variables found as the possible factors contributing to the delay in providing project information by the engineer to the contractor as shown in Table 1.

Table 1. Possible Factors Influencing Delay of Issuing Project Information

Category	No	Possible Factors Influencing Delay of Issuing Project Information	Reference
Project characteristics	F1-F14	Project type, project size, type of SFoC use, procurement method used, adequacy of design details and specification, project complexity, ground uncertainty, surrounding uncertainty, project scope change, design changes, ease of site access, tight project milestone, technological advancement requirement, multicultural team	Krima et al. (2007); Marique (2013); Ismail (2019); Guo et al. (2016); Winch (2002); Jaffar et al. (2011)
External factor	F15-F18	Resources availability, changes in government regulations and laws, bureaucracy of government agencies, weather condition	Yong & Mustaffa (2016); Sambasivan & Soon (2007); Iyer & Jha (2005); Jaffar et al. (2011); Yu & Shen (2013); Songer & Molenaar (1997); Shehu et al. (2014)
Quality of SFoC	F19-F22	Fairness of SFoC content, clarity of SFoC content, completeness of SFoC content, trust produced by SFoC content	Iyer & Jha (2005); Shehu et al. (2014); Ahmed & Othman (2013); Alkhamali et al. (2010); Nachatar et al. (2003); Gosling et al. (2013)
Attitude of participants	F23-F27	Level of SFoC compliance, level of understanding the content of SFoC, familiarity of procurement method used, Cooperation in solving problems, Competency of engineer	Chan (2003); Rameezdeen & Rodrigo (2010); Ali & Wilkinson (2010); Chong & Zin (2010); Wright & Ferguson (2009)

METHODOLOGY

The data collection method was conducted out in two stages, starting with a questionnaire survey and followed with semi-structured interviews. There were two target population frames comprised of professional engineers registered under the Board of Engineer Malaysia (BEM) and Grade G7 contractors registered with the Construction Industry Development Board (CIDB) identified as the respondents. The data collection started with sending out 1000 questionnaire surveys to the targeted populations. Then, follow up involving telephone calls were done to remind the respondents and solicit their cooperation. The survey was phrased to ask the respondents to rate the level of influence of the twenty-seven (27) factors as listed in Table 1 based on their judgement and working experience in civil engineering projects. These possible influencing factors were presented for assessment in the way to determine which of them has the highest reason for the occurrence of delay in issuing project information in civil engineering projects in Malaysia.

The influence level is measured on a 5-point Likert scale, where (5) denotes very high influence, (4) high influence, (3) moderate influence, (2) low influence, and (1) very low influence. This kind of scale is used to calculate the mean score for each factor, which is then used to determine the relative ranking of each factor by assigning a ranking to mean score, with the low mean score assigned low ranks and high scores allocated high ranks (Shehu et al., 2014; Aziz & Abdel-Hakam, 2016). This study used the same analysis technique as used by Shehu et al. (2014) to determine the ranking of each variable. The author claimed that the indexing by means of the mean score is suitable and has been used by many researchers in presenting descriptive data analysis.

After the result of the questionnaire survey was obtained, the data collection method proceeded with semi-structured interviews. Previously in the questionnaire survey forms, the respondents were requested to take part in the subsequent semi-structured interview session for detailed thoughts on the most significant factors and received 28 positive responses from them. Thus, the participants were informed on the most significant factors obtained from the questionnaire survey. Interview questions were developed to guide them during the interview session. Firstly, they need to rate their level of agreement using a 5-points Likert scale where 1 as "very disagree", 2 as "disagree", 3 as "moderate", 4 as "agree" and 5 as "very agree". Next, the participants were asked to provide their insight on each of the significant factors obtained earlier in the questionnaire survey. Before the interviews data were analysed, each interview discussion was transcribed into a text document. Overall, 28 interview audios were transcribed and then analysed manually.

RESULT AND DISCUSSION

Questionnaire Result and Analysis

Out of the 4151 eligible population, the estimated sample size of this study was 255 which was calculated using Raosoft sample size calculator. This calculator is reliable and has been used by many researchers in construction management field such as Araujo et al. (2019) and Desa et al. (2012). Prior to distributing the questionnaire, a pilot survey was undertaken by distributing 60 questionnaires to the target population. After two weeks, 38 responses were received. The reliability test was conducted and the overall Cronbach's coefficient alpha value was 0.802. This verifies that all variables in the study demonstrate internal consistency and the main survey could be distributed. After a period of 6 weeks, with 29% response rate, a total of 288 responses were received. There were 151 contractor respondents and 137 engineer respondents.

Respondent's Demographic

As portrayed in Table 2, most respondents have extensive experience dealing with civil engineering for more than 10 years. 49% of engineer respondents and 46% of contractor respondents have experiences between 6 to 10 years. Very few respondents have experiences between 2 to 5 years with only 8% of the total respondents.

Table 2. Demographic Background of Respondents

Experience in civil engineering projects (years)	Contractor		Engineer	
	Frequency	(%)	Frequency	(%)
More than 10 years	70	46	70	51
6 to 10 years	69	46	67	49
2 to 5 years	12	8	0	0
Less than 2 years	0	0	0	0
Total	151	100	137	100

The Most Significant Factors Influencing Delay of Issuing Project Information

In this study, the factors considered as having the most significant influence were the factors with the mean values between 4.00 to 5.00 (Shehu et al., 2014; Adedokun et al., 2013;

Duy Nguyen et al., 2004). Table 3 depicts the result of the assessment where there were five (5) factors namely project scope changes, ground uncertainty, surrounding uncertainty, adequacy of details and specifications and competency of engineer score the mean value between 4.04 to 4.39. Hence, these five factors were the most significant in contributing to the delay of issuing project information. In the meantime, fourteen (14) factors were found to moderately influenced with the mean values between 3.05 to 3.94. They were changes in initial design, project complexity, bureaucracy of government agencies, weather condition, cooperation in solving problems, changes in government regulations and laws, familiarity of procurement method used, poor in complying the condition of contract, tight project milestone, resources availability, site access, project size, level of understanding condition of contract, and completeness of SFoC. The eight (8) remaining factors perceived to have low influence.

Table 3. The Ranking of Factors that Influenced Delay of Issuing Project Information

Factors Influencing Delay of Issuing Project Information	Overall		Engineer		Contractor	
	Mean	Rank	Mean	Rank	Mean	Rank
Project scope changes	4.39	1	4.41	1	4.36	1
Ground uncertainty	4.31	2	4.29	2	4.32	3
Surrounding uncertainty	4.29	3	4.23	3	4.34	2
Adequacy of details and specifications	4.08	4	4.15	4	4.01	4
Competency of engineer	4.04	5	4.07	5	4.01	5
Changes in initial design	3.94	6	3.91	7	3.97	6
Project complexity	3.91	7	3.85	10	3.97	7
Bureaucracy of government agencies	3.89	8	3.91	8	3.87	8
Changes in government regulations and laws	3.87	9	3.91	9	3.87	9
Weather condition	3.86	10	3.95	6	3.79	10
Cooperation in solving problems	3.75	11	3.77	11	3.74	11
Familiarity of procurement method used	3.40	12	3.50	12	3.32	12
Poor in complying the condition of contract	3.31	13	3.46	13	3.18	15
Site access	3.26	14	3.28	15	3.25	13
Tight project milestone	3.22	15	3.29	14	3.16	17
Resources availability	3.18	16	3.15	18	3.21	14
Project size	3.16	17	3.15	19	3.17	16
Level of understanding condition of contract	3.16	18	3.26	16	3.07	18
Completeness of SFoC	3.05	19	3.17	17	2.93	19
Technological advancement	2.86	20	3.01	20	2.72	21
Multicultural team	2.79	21	2.79	22	2.79	20
Fairness of SFoC	2.67	22	2.91	21	2.45	22
Procurement method	2.52	23	2.66	23	2.40	23
Trust produced by SFoC	2.36	24	2.39	26	2.34	24
Project type	2.35	25	2.43	24	2.28	25
Type of SFoC	2.31	26	2.41	25	2.21	26
Clarity of SFoC	2.23	27	2.29	27	2.17	27

Out of the five (5) significant factors, *project scope changes, ground uncertainty, site surrounding uncertainty* and *adequacy of details and specifications* were under the project characteristics domain. This shows that the project characteristics contribute highly to the occurrence of delay in providing project information in civil engineering projects compared

to the other three domains. The uniqueness of civil engineering projects compared with general buildings makes their design and scopes cannot be accurately developed before the construction proceeds on site. Typically, the projects are designed for specific purposes and cover very large geographical areas. Hence, they are very vulnerable to a variety of unforeseeable ground conditions. Consequently, the details of the projects are usually incomplete and have to undergo revision from time to time along with the implementation of construction (Ismail et al., 2019). Jaffar et al. (2011) opined that it is impossible to have a set of drawings in a construction project which is complete or faultless. The incidents of wrong scales, some missing details or dimensions, errors in elevations and many more are prevalent in any construction project. Consequently, the issuance of project information to the contractor might have to be revised and hence cause the delay.

Meanwhile, the unpredictable ground and site surrounding conditions also cause the delay to occur. For instance, the original design of the foundations may need to be altered or revised due to the unexpected condition of the soil at a certain depth. In fact, in an extreme case, the original design and the works may have to be abandoned altogether which leads to a change of the original project scope. This kind of occurrence might be due to inadequate site and soil investigation (SI) carried out before the development of design. Whereas, the process of developing a comprehensive design requires data from a complete and precise SI such as the site topography, test pits, utility locations and soils analysis. Aziz & Abdel-Hakam (2016) reported that inadequate geotechnical investigations in road projects in Egypt have caused project delay because of design revision due to the incomprehensiveness of the original design. As a result, the process of redesigning or revision of the original design by the consultant can cause delays in issuing project information. Without a proper management and coordination regarding to the issues of unpredictable ground and surrounding conditions, the occurrence of delay could be more severe.

The remaining factor that has a high influence on the delay of issuing project information was the *competency of engineer* in supervising and managing the construction works. According to Atout (2016), the majority of delay in issuing project information to the contractor can be traced due to incomplete or inconsistent detailing of drawings, incorrect dimensions, inadequate detailing of difficult or complex locations. Whereas, a complete and comprehensive design is very important in ensuring the smooth running of the construction project. Therefore, a competent engineer in developing a comprehensive design is critical to reducing future design revision once the project starts the construction process. The failure in considering the functionality and constructability of the design as well as identifying any obstacles that might be faced could increase the possibility of revision of original design during the construction stage. Abdallah et al. (2019) outlined that comprehensive design must fulfil the criteria of timeliness, accuracy, completeness, coordination and conformance. Hence, with a comprehensive design development, the massive revision of design could be avoided once the construction starts on site. Overall, this can be concluded that, out of twenty-seven (27) factors assessed, only five (5) factors were found to significantly influence the occurrence of delay of issuing project information from engineer to contractor.

Semi-Structured Interview Result and Analysis

The purposive sampling strategy was adopted to select the semi-structured interview participants. Sekaran & Bougie (2010) mentioned that the purposive sampling is narrowed to

specific group of people who can deliver the needed information. The participants are selected based on characteristics of the population that fulfil the criteria set by the researcher. Hence, the suitable participants for this study were the engineers and the contractors. The analysis of the interviews focused on in-depth discussion on the five significant factors contributing to the delay of issuing project information in civil engineering projects obtained from the questionnaire analysis.

Participants' Background

There were 28 participants agreed to participate, 57% of them were contractors and another 43% were engineers. All of the participants have experience more than five years dealing with civil engineering projects in Malaysia where most of them have more than ten years' experience. Both engineers and contractor participants' positions were at the executive level and directly involved in the project implementation.

Table 4. Interviews Participants

Contractor Participants			Engineer Participants		
ID	**Position**	**Experience (years)**	**ID**	**Position**	**Experience (years)**
C1	Senior Contract Manager	15	E1	Resident Engineer	9
C2	Project Manager	10	E2	Resident Engineer	20
C3	Project Engineer	8	E3	Road Engineer	12
C4	Project Manager	12	E4	Project Coordinator	12
C5	Project Engineer	10	E5	Project Engineer	10
C6	Senior Quantity Surveyor	10	E6	Principal Engineer	9
C7	Planning Engineer	16	E7	District Engineer	18
C8	Senior Quantity Surveyor	9	E8	Bridge Engineer	13
C9	Site Quantity Surveyor	8	E9	Road Engineer	16
C10	Site Engineer	6	E10	Road Engineer	10
C11	Project Manager	13	E11	District Engineer	18
C12	Project Manager	9	E12	Project Engineer	6
C13	Site Engineer	10			
C14	Quantity Surveyor	13			
C15	Site Engineer	7			
C16	Site Engineer	8			

The Most Significant Factors Influencing Delay of Issuing Project Information

Table 5. Participants' Agreement on the Most Significant Factors Influencing Delay of Issuing Project Information

The Most Significant factors	**Level of agreement**										**N**
	Very disagree							**Very agree**			
	1		**2**		**3**		**4**		**5**		
	No	**%**	**No**	**%**	**No**	**%**	**No**	**%**	**No**	**%**	
Project scope change	0	0	0	0	0	0	10	36	18	64	28
Ground uncertainty	0	0	0	0	0	0	12	43	16	57	28
Site surrounding uncertainty	0	0	0	0	0	0	13	46	15	54	28
Adequacy of details and specifications	0	0	0	0	0	0	9	32	19	68	28
Competency of Engineer	0	0	0	0	0	0	0	0	28	100	28

Based on the questionnaires results and the feedback of those who were interviewed, it is found that their opinions showed similarity. As tabulated in Table 5, all participants agreed that project scope change, ground uncertainty, site surrounding uncertainty, adequacy of details and specifications and competency of engineer were the most significant factors contributing the delay of issuing project information in civil engineering projects.

The opinions of participants on each of them were:

a) Project Scope Change

The majority of participants acknowledged that the original project scope changes mainly because of the inadequacy in project definition and requirement as well as unpredictable ground and surrounding conditions. They claimed that in the event of a project scope change, the probability of the design to change is high. Hence, the amendment of the original drawing may require some time to be done. The problem could be more severe if there is a lack of engineer experience and resources in responding to the changes. This is in lined with the finding of a study by Aziz & Abdel-Hakam (2016) that the delay of approval by the engineer on the major changes in the project scope significantly causes the overall delay of road projects in Egypt. These consequently might be reflecting on the contractor performance because the labour, material, equipment and financial might be difficult to estimate and allocate due to the design changes (Atout, 2016). Consequently, affect the overall project implementation.

b) Ground Uncertainty

Most participants agreed that due to unpredictable ground conditions, most of the time adjustments or amendments to the original design cannot be avoided. Thus, it requires some time for the engineer to redesign or revise the original drawings. Two participants reported that changes of initial scope and design are among the main factors causing delays in issuing project information by the engineer. They mentioned that based on their experience, the changes of initial design are common during construction implementation because of the unpredictable ground conditions or to suit requirements by the Local Authority. Besides, the unforeseeable force of nature that severely obstruct the operation of works on site also may require some emergency adjustment to the original design. Unavoidably, these could lead to delay in issuing drawings, specifications, instructions as well as approvals to the contractor. Although the impacts of original project scope changes on the delay of issuing project information to contractors would be very severe, they highlighted that this incident does not commonly occur. The client and consultants try to avoid the project scope changes as much as they can due to the awareness of the severity of impacts it might bring.

c) Site Surrounding Uncertainty

The majority of participants highlighted that site surrounding uncertainty if any, could lead to changes of the original drawing or scope of projects such as objections by local people on the project implementation or problems with land acquisition. Indeed, especially for civil engineering projects such as roads, highways and railways, problems associated with land acquisition is prevalent (National Audit Department Malaysia,

2016). The construction works that should have been commenced on site based on the work program but must be adjourned due to the obstruction by the land owners. The participants mentioned that due to no agreement achieved with the local people or problems of land acquisition from a few land owners, the scope or design occasionally would have to undergo slight or major amendment. Hence, the engineers also require more time to investigate the ground and sometimes carry out additional soil investigation before any new design could be produced. Consequently, this amendment may take a longer time and cause a delay in issuing timely information to the contractor. However, they asserted that this kind of incidence does not frequently occur.

d) Adequacy of Details and Specification

The majority of participants acknowledged that delay in issuing project information could be due to inadequacy of design development or details when construction started to proceed on site. Thus, the original design might have to be reviewed from time to time as the construction progresses on site. Some participants highlighted that in the present days' context, due to the fact that construction schedules are compressed for faster completion, construction activity starts even before the final design is completed. This might lead to the following of inaccurate design or inadequacy of details and specifications. Indeed, many problems occur in detailed and schematic design that makes the conflict between structural and services drawing details become the norms (Yong & Mustaffa, 2012; Karunakaran et al., 2019; Russell et al., 2014). As a result, the revision or additional information might be required to be done from time to time as the construction on site progresses. Moreover, a number of respondents asserted that due to urgency to start construction on site, every designer or everyone who has worked in producing design and drawings will be aware that it is impossible to produce a set of drawings which is complete or without error. Sometimes, there are missing in dimensions, wrong scales and details missing found in the drawings (Jaffar et al., 2011). All of these require drawing revision or amendment, thus, causing a delay in providing drawings or other important information required for the contractor to carry out construction on site.

e) Competency of Engineer

All of the participants agreed that the competency of engineers in designing the project as well as in supervising all aspects of the construction process is important to ensure project success. In the aspect of delay of issuing information such as drawing or instruction, all participants agreed that the significant factor causing it is the competency of the engineer. They envisaged that the problems of delay of issuing the required information to the contractor might be eliminated if the engineer is competent in carrying his roles in the project. In order to avoid delay in issuing the project information, the engineer must have knowledge and expertise of the particular type of civil engineering project. Hence, the adequate qualification of the engineer and the key staff assigned to the project is important. Their opinions are in line with Yong & Mustaffa (2012) who also opined that knowledge and experience consultant likely to have better competency and ability to manage a construction project successfully. Likewise, Atout (2016) asserted that the problems of delay in many aspects of construction project mostly are because of the lack of designer's experience in recognizing the project technical design specification that must comply with the project requirement. In addition, the knowledge and competency

of the engineer to arrange and deal with the local authorities and stakeholders are very important to in obtaining all requirement and approval of the developed design (Yong & Mustaffa, 2012). Although, the submittal and approval process of the final developed design may take some time but with a regular coordination and double efforts by the engineer could expedite approval process.

CONCLUSION

The significant factors influencing the delay in issuing project information determined in this study are reliable because there are undergone two-stage of data collection via questionnaire survey and interviews. The finding shows that project scope changes, ground uncertainty, site surrounding uncertainty, adequacy of details and specifications of original design and competency of engineer are the five factors as being extremely high significant in influencing delay of issuing project information in civil engineering projects in Malaysia. Out of the five significant factors contributing to the occurrence of a delay in issuing project information, four of them were related to the characteristics of civil engineering projects which are full of uncertainty and complexity in nature. Many decisions for the project are made based on the data and information obtainable at the beginning of the project. Hence, a procurement arrangement and contract that could effectively respond to the unpredictable ground and the surrounding conditions is important to be properly selected. The use of the traditional method seems does not appropriate to flexibly and economically react with the uncertainty problems. Besides, the competency of the engineer in project management in terms of technical, teamwork, decision making, planning and scheduling is also critical in avoiding the delay of issuing project information to the contractor. The outcome of this study revealed and highlighted the determinants that are common in construction projects but very significant to cause the delay of issuing project information by the engineer. This would be useful for the client and consultant in planning the protective measure to avoid problems during project implementation. Hence these five factors must be well understood and put more concern by the client and engineer in order to overcome the severity occurrence of delay of issuing project information in future civil engineering projects.

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GUIDE TO AUTHORS

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

Articles submitted will be reviewed and accepted on the understanding that they have not been published elsewhere. The authors have to fill the **Declaration of the Authors** form and return the form via fax/email to the secretariat. The length of articles should be **between 3,500 and 8,000 words** or **approximately 8 – 15 printed pages (final version)**. **The similarity index must be lower than 20% and the Similarity Report must be submitted together with the manuscript.**

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CODIFICATION AND APPLICATION OF SEMI-LOOF ELEMENTS FOR COMPLEX STRUCTURES

(FULL NAME) Ahmad Abd Rahman[1], Maria Diyana Musa[2] and Sumiana Yusoff[2]
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[2]Institute of Ocean and Earth Sciences (IOES), University of Malaya, Malaysia

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

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

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

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

Heading 3 (Arial Italic + Lower Case, 11pt)

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

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

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

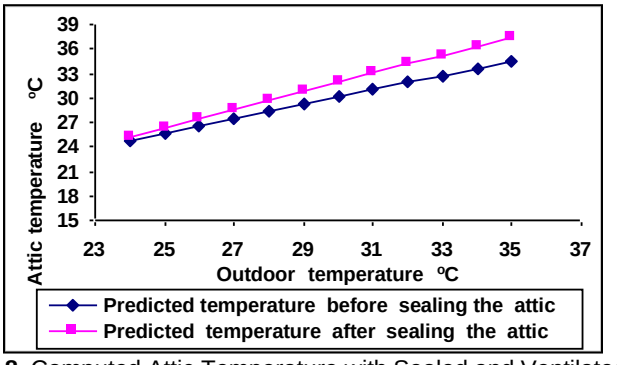

Figure 8. Computed Attic Temperature with Sealed and Ventilated Attic

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

Table caption: Arial Bold + Arial, 9pt. + Capitalize Each Word. Captions should be written above the table.

Table Line: 0.5pt.

Table 1. Recommended/Acceptable Physical Water Quality Criteria

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

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

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

Citation:

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

(Source: UPSI, 2019)

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

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

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