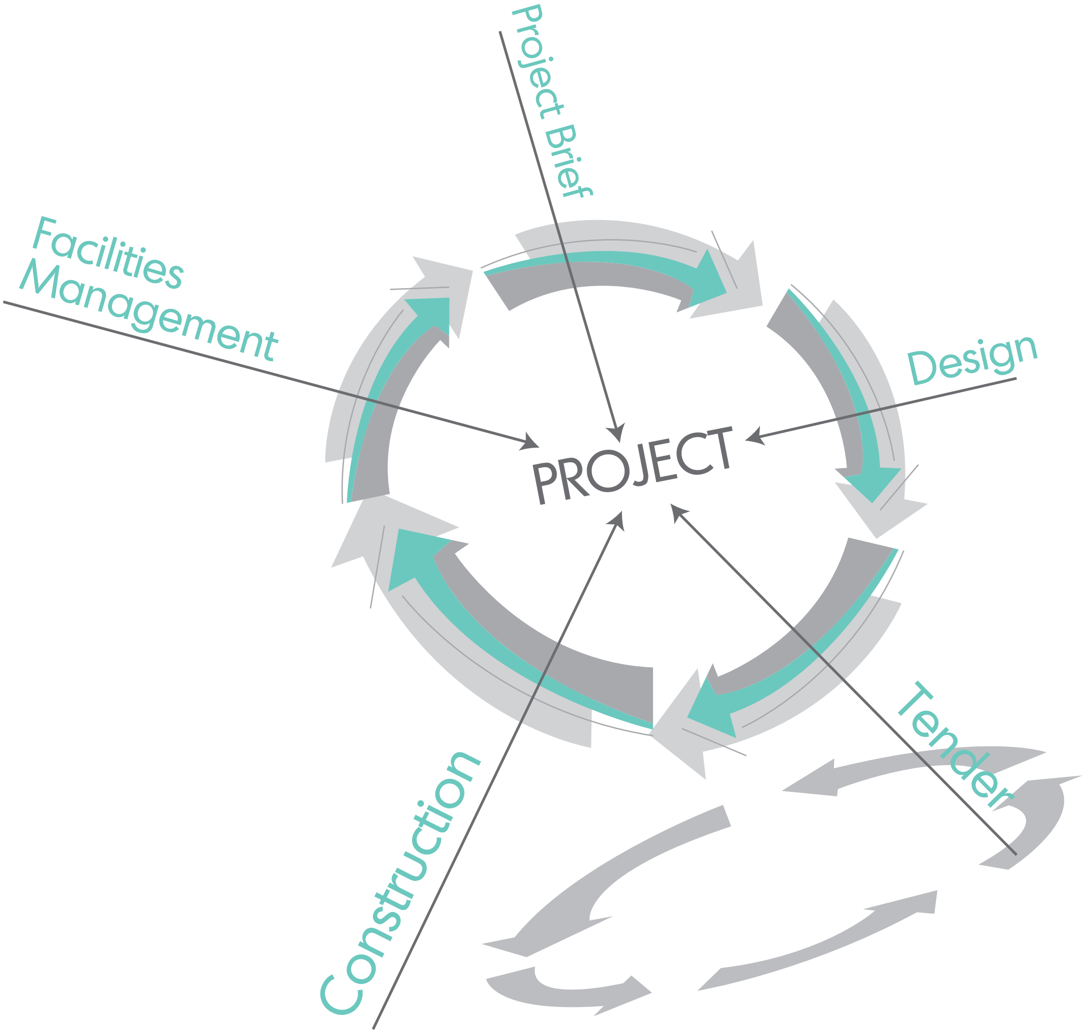
MCRJ Volume 35 | No.3 | 2021

ISSN No. : 1985 – 3807
eISSN No. : 2590 – 4140

Malaysian Construction Research Journal



CREAM CONSTRUCTION RESEARCH INSTITUTE OF MALAYSIA

CIDB MALAYSIA

MALAYSIAN CONSTRUCTION RESEARCH JOURNAL (MCRJ)

Volume 35 | No. 3 | 2021

The Malaysian Construction Research Journal is indexed in

Scopus Elsevier

ISSN No. : 1985 – 3807
eISSN No. : 2590 – 4140

Construction Research Institute of Malaysia (CREAM)
Level 29, Sunway Putra Tower,
No. 100, Jalan Putra,
50350 Kuala Lumpur
MALAYSIA

Contents

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Editorial

Welcome from the Editors

Welcome to the thirty-fifth (35th) issue of Malaysian Construction Research Journal (MCRJ). In this issue, we are pleased to include nine papers that cover a wide range of research areas in construction industry. The editorial team would like to express our sincere gratitude to all contributing authors and reviewers for their contributions, continuous support and comments.

In this issue:

Siti Haizan Azmi et al., assessed the criteria on design and features of green office buildings in Klang Valley and Putrajaya. The methodology used in this study is through content analysis which consisted of five (5) numbers of office buildings. The findings show that the Green Building Index (GBI) certified buildings has achieved all six (6) criteria which include Energy Efficiency, Indoor Environment Quality (IEQ), Sustainable Site Planning and Management, Materials and Resources, Water Efficiency, and Innovation.

Nabila Huwaina Ramli et al., identified the financial risk in Public-Private Partnership (PPP) in Malaysia. The methodology adopted for this study is through the distribution of a questionnaire to the 66 companies. There are 24 classifications of financial risk in PPP Projects and 16 financial risk management in PPP projects. The conclusion can be made from this study is the highest mean value is risk analysis, identification and management to deal with uncertainty and unexpected event in terms of scope, time, cost and quality. Meanwhile, the respondents were least agreed with the Guideline from the Government to enhance a good financial plan.

Ani Saifuza Abd Shukor et al., investigated the relationship between Building Information Modeling (BIM) and job performance among professionals. Stratified sampling was used as a research sample, with the population of 242 professionals consisted architects, engineers and quantity surveyors. The data analysis used in this study is multiple regression analysis and Analysis of Variance (ANOVA). The findings has categorised four (4) main factors that contributed to the job performance namely Human Capital, Organisation Capital, Physical Capital and Relationship Capital. All those factors have shown a positive relationship towards job performance.

Siti Suhana Judi and Nur Emma Mustaffa explored the issues of late and underpayment in the Malaysian construction industry. A qualitative research method through semi-structured interviews among private clients and G7 contractors was done. Six (6) causal components of late and underpayment issues were identified as the findings in this study which comprises of Lack of Trust between client and contractor, Contractor's lack of knowledge in Variation Order (VO) documents submission, problems in the providing claim documents, lack of competent staff, insufficient financial resources and no participation in joint project valuations. The findings have identified six (6) proactive solutions involving providing quality staff in the organisation, developing trust between parties, using appropriate contracts, enhancing financial management, improve payment procedures and external benchmarking.

Mustafa Fawaz et al., discussed the key area of Building Information Modelling (BIM) that could support the clash management process during a project's lifecycle, barriers and challenges and the use of BIM technology. The discussions are categorised into three sections which are Process, Organisation and Product. It can be concluded that by proposing a Model for Management Alignment for BIM Automation in Clash Management Process where appropriate optimisation in supporting BIM implementation and improving construction productivity could be developed through incremental alignment of BIM product to the management team's action.

Mohd Arif Marhani et al., developed a Lean Construction (LC) tools framework that can enhance the contractor's time performance by minimising construction wastes at the site. The methodology used in this study is through a quantitative method using a survey questionnaire distributed to the 310 G7 contractors registered with Construction Industry Development Board (CIDB). The findings show that Teamwork can reduce the late work delivery while Management Contract could reduce two (2) factors of activity start delays and ineffective work. Concurrent Engineering indicates reducing work interruptions. It can be concluded that these 3 focus areas are effectively implemented in organisations and successfully embrace the flow delivery of their construction projects.

Nurhuda Athira Zainudin et al., studied the risk allocation for different procurement types in construction projects focusing on three (3) types of procurement which are traditional, design-build and public-private partnership (PPP). The quantitative method was used through the distribution of 354 sets of questionnaires to the selected companies in Klang Valley. Based on the findings, three (3) main factors that contributed to the risk occurrence are unstable government, delay in project approvals and permits, and fluctuation of material cost. It can be concluded that in Traditional procurement, the risks allocated between contractor and clients are balanced where the risks are allocated based on its nature of work. While for the Design-Build procurement, the majority of the risk is suggested to be managed by the contractor. The PPP procurement is based on the cooperation between public and private sectors; thus, the risks are most likely to be shared between contracting parties.

Wan Norizan Wan Ismail and Hamimah Adnan analysed the significant factors influencing the occurrence of unauthorised instructions in civil engineering projects. The methodology used in this study is a quantitative method through the distribution of survey questionnaires to the 288 professional civil engineers and G7 contractors. The findings show the highest factor that influenced unauthorised instructions is poor in complying condition of a contract, followed by the level of understanding condition of the contract and ground uncertainty. Three (3) domains were identified at the end of the discussion which is project characteristics, the attitude of the key participant and quality of SFoC. It can be concluded that the occurrence of unauthorised instruction is at a high level in Malaysian civil engineering projects.

Souksamay Manhmanyvong et al., evaluated and strengthen the Local Government (LG) practice of Own Resilience and Flood Risk Management (ORFRM) in Xay District, Lao People's Democratic Republic. Four (4) methods were used for data collection purposes which are desk research. Direct observation, semi-structured interviews and focus group discussions. The findings show 26 factors for ORFRM in all three flood cycles (before, during and after). The flow of implementation is through strengthening Local Government practice of ORFRM. Besides that, policies and plans for both structural and non-structural measures should be implemented.

Editorial Committee

ASSESSING CRITERIA ON DESIGN AND FEATURES OF GREEN BUILDING

Siti Haizan Azmi[1], Hamimah Adnan[1], Mohamad Sufian Hasim[1], Wan Norizan Wan Ismail[2] and Noor Akmal Adillah Ismail[1]
[1]Centre of Studies for Quantity Surveying, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Shah Alam, Malaysia.
[2]Department of Built Environment Studies and Technology, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA Perak Branch, Seri Iskandar, Perak, Malaysia.

Abstract
The characteristic of green office buildings is different from the conventional buildings due to the complexity in design and construction. The uncertainty in the implementation of green buildings makes it impossible for the key participants to strictly comply with the provisions stipulated in a contract. In order to overcome unsatisfactory performance, the criteria of green office building must be taken into consideration by the key participants who manage this type of building. This paper aims to assess criteria on design and features of green office building through content analysis. It was found that this reports on the results of the content analysis which collected data on design and features of green office building implemented by the designers. A list of GBI -Certified Green Office Buildings under New Construction Category in Malaysia was assessed. Five (5) numbers of office buildings in Klang Valley and Putrajaya area were selected to present features of green office buildings applied by the designer to fulfil the green building criteria hence achieving GBI certification. The features of each green building obtained from various relevant websites were compiled based on the six (6) criteria listed under GBI. Though the system and materials might be slightly different from one green buildings to another, there are similarities in terms design principal; by incorporating advanced green technologies, sustainable energy solutions, innovative energy management systems and rainwater harvesting systems into the design. Thorough consideration has been given by the project team to produce a building that is environmentally, socially and economically friendly. This is achieved by enhancing good passive designs and integrating active (mechanical and electrical) design and system to deliver and to offer significant long-term comfort and savings for the building owners and occupants.

Keywords: *Contractual behaviour; green office building.*

INTRODUCTION

Green building concept has many environments, social and economic advantages. The growing demand and rapid growth of green buildings concept globally caused the construction key participants (architects, engineers, quantity surveyors, and environmentalists) to rethink the way buildings are constructed and the need to reduce the cost escalations and construction time frames (Babu Reddy, 2017). Unfortunately, green buildings experience less successful project delivery (Zhang et al., 2019) and despite the fact that the green building concept has many environments, social and economic advantages, there are still many issues clouding this new approach that slow down the growth of green buildings in Malaysia. According to previous research, it appears that green office building projects throughout the world face similar challenges, which are exacerbated by quality issues, schedule and cost overruns. In order to overcome these issues, scholars have put responsibility on the key participants of the project to act accordingly. This raises the issue of key participants' poor performance in managing green office building projects. Meanwhile, problems associated with key participants' contractual behaviour continue to plague the Malaysian and international construction industries. According to Wan Ismail et al. (2018), contractual behaviour of key participants refers to commitment and action implemented by the people who has been given the authority to make decision by the contract. The majority of the causes of unsatisfactory construction project performance are frequently related to the contractual behaviour of key participants who failed to perform duties and obligations in accordance with the Standard Form of Contract, such as delay of payment by client, poor contractor's coordination and progress on site, poor communication and consultant's failure to deliver timely information and supervision. Although the construction management field has long verified that the contractual behaviour of key participants affects the project performance, none of the aforementioned researchers refer to or classify such variables as key participant contractual behaviours. Due to its complex characteristic and uncertainty, green buildings definitely demand more cooperation from all key participants and the finding may be different from those of general construction project. Hence this study is to identify the criteria on managing the design and features in managing green office building projects.

LITERATURE REVIEW

Green Office Building

Green office buildings, or also known as sustainable buildings, refer to buildings that have the characteristics of greenness and have secured recognition from an appropriate green eco-labelling agency [9]. In Malaysia, Green Building Index (GBI) System is used to evaluate the environmental design and performance of a building. Green Building Index rated buildings into 3 categories; Non-Residential (NR), Residential (R) and Industrial Buildings (IB) according to their functions and energy usage. For Example, Residential buildings function differently from Commercial, Industrial or Institutional buildings and have different peak-use periods. Non-Residential buildings like office buildings, hospitals, shopping malls and conventions usually operate at maximum capacity during the day whilst homes peak during the evening and night. Application for GBI can be made for New Construction as well as for Existing Buildings which will be assessed accordingly using the appropriate criteria. An office building must fulfill 6 criteria listed in Green Building Index (GBI) rating system to be recognised as green; which are Energy Efficiency, Indoor Environmental Quality, Sustainable Site Planning and Management, Materials and Resources, Water Efficiency and Innovation.

There are passive and active design features applied by the designers to improve building energy efficiency, indoor environment quality (IEQ) and water efficiency so that the buildings ticked all the criteria required by the GBI rating tool system. Passive design contributes to less dependency to mechanical and electrical equipment for cooling, heating, ventilation and lighting which always demand high energy to operate. Active design feature in green buildings on the other hand refers to element introduced to the green building in order to react to the surrounding and actively bring different result such solar panels. Consequently, green design criteria applied by the designers to obtain GBI certification has increased expenditures for green appliances and energy-saving materials. Besides that, incorporating green technologies and recycled materials in the green office building design also involves lengthy planning and approval process.

RESEARCH METHODOLOGY

Content analysis a research method used by synthesizing a diverse data and information including texts, images and symbols into a highly structured and concise summary of key findings (Krippendorf, 2019). Content analysis required human efforts to manually collect, transcribe and code textual data when it was first in psychology and social science in 1970s. The widespread of electronic and hence computer readable, text concerning virtually everything has moved content analysis to a more convenience research method adopted in social science, humanitaries and business field. This study performed the content analysis to gather information and data about green office buildings. Information and sufficient data obtained from browsing through websites were further compiled and organized systematically to facilitate interpretation in regards of green office buildings. Themes, patterns, and limitations on green office buildings were identified, hence become a guidance that provides understandings into the fundamental criteria of green office buildings.

Content analysis for this study undertakes 45 relevant websites. The search was conducted by typing specific general words (green buildings, green office building, green building index) and narrow down to specific words (energy efficiency, indoor environment quality water efficiency sustainable site planning and management, green materials, innovation in green office buildings). Firstly, GBI certified buildings were identified from a specific website called Green Buildings Index where the website provides information on buildings in Malaysia with green building certification. In this study, buildings under the category of Non-Residential New Construction (NRNC) were examined and among five hundred seventy (570) NRNC, 95 numbers of GBI certified Green Office Buildings were identified. Five (5) sample buildings were chosen from the list to be studied further. The GBI certified buildings were selected based on their similarity in terms of main function and location. All the five (5) sample buildings are within Klang Valley and Putrajaya province. The pdf documents attached on the website regarding GBI marking scheme were also studied to get a clearer picture on main features of green office buildings.

As the GBI website does not provide detail design information of each buildings, further searching has been carried out on each particular buildings using Google search. Specific information of each building was obtained by typing the name of the buildings. Key words such as “energy efficiency features of Building A”, “Innovation in Building B”, “Indoor Environment Quality in Building C”, “Green features in Building A” etc were used to seek detail information of green features applied by the designers in each building.

The detailed procedure was as follows:

1. The information on green office building was identified and relevant data sets and information were defined. Criteria of GBI were studied and specific information of each criterion were examined from the relevant document attached on the website.
2. GBI certified building were identified and detailed study of each identified buildings were carried out. The data obtained from the study were organized by putting them into specific columns in a data table according to the six (6) criteria.
3. The data were reviewed to make sure that they were placed under the right heading and are relevant to the objective of this study. Unrelated data were eliminated.
4. The common features and design of green office buildings that fulfilled GBI certification criteria were comprehended.

FINDINGS AND DISCUSSION

This section reports on the results of the content analysis which collected data on design and features of green office building implemented by the designers. A list of GBI - Certified Green Office Buildings under New Construction Category in Malaysia was assessed. Five (5) numbers of office buildings in Klang Valley and Putrajaya area were selected to present features of green office buildings applied by the designer to fulfil the green building criteria hence achieving GBI certification. Then, the features of each green building obtained from various relevant websites were compiled based on the six (6) criteria listed under GBI. Table 1 depicted design and features of five (5) samples green office buildings arranged according to six (6) GBI criteria.

Energy Efficiency

According to Lin et al. (2016), green buildings used a mean 21% lower energy than conventional buildings. It was discovered that the introduction of energy efficient features enabled savings of up to 46% of total energy expenditures, particularly on electricity bills. Soon et al. (2017) stated that the technology incorporated in the green buildings would allow them to be more energy efficient. Older technology in conventional buildings is not as effective as in green buildings in decreasing the energy required during the operational stage. Though green buildings always associated with high upfront cost especially due to high-end technology introduced in the design, the maturity of the market will turn the cost to be more competitive in the future. For example, solar photovoltaic system which is a very popular green building feature in GBI certified buildings in Malaysia like in Persatuan Arkitek Malaysia (PAM) building, Menara Worldwide, LEO Buildings and Menara Kerja Raya, has shown 80% reduction in prices since 2009. High energy efficiency lights, LED lights, or natural skylights are installed in all five buildings to minimises the amount of energy consumption. Furthermore, Variable Refrigerant Flow (VRF) system in PAM Building, Variable Air Volume (VAV) in Menara Worldwide, Chilled Water storage (CWS) system in Menara LGB and Variable Air volume (VAV) in LEO buildings are integrated in air-conditioning system to lower the energy consumption from air- conditioning. Besides active design, passive design approach such as proper placement of windows in Menara Kerja Raya and LEO buildings by setting south and north facing windows as well as the use of architectural features like atrium in PAM building to reflect light into a building has reduce the need for artificial lighting. Common features like applying appropriate insulation and high-performance, Low-E windows in green buildings help to obtain energy efficiency can be spotted in all five buildings. Consequently, a study done by Soon et al. (2017) found the energy costs incurred in a green certified office building in Malaysia is only about 46% of a conventional building.

Table 1. Design and Features of Green Office Buildings

CRITERIA	GBI-CERTIFIED BUILDINGS				
	A	B	C	D	E
Energy Efficiency (EE)	• Roof terrace area filled with greenery that contains the building's solar system • Use VRF system, a more energy-efficient air conditioning system with the ability to control individual spaces independently • 25kWp photovoltaic system	• Variable air volume (VAV) air conditioning system	• Chilled water storage (CWS) system is employed to lower the energy consumption from air-conditioning • Energy-saving lightings	• Lighting design 8W/m2	• Variable air volume (VAV) air conditioning system • Installation of high efficiency light fixtures • Energy Efficient office equipment (less electricity use and less cooling demand) • High efficiency motors (HEMs) for pumps and fans, with variable speed drives (VSDs) for optimum operational efficiency
Indoor Environmental Quality (IEQ)	• Natural Ventilation • Open design to keep circulating the air inside the building. Black aluminium screen that envelopes the building's concrete façade • Stepped atriums promote cross ventilation • Squarish openings and skylights promote natural lighting, cool the building, and reduce the use of electricity. Big propeller is installed to optimise air circulation	• Floor-to-floor windows to allow good ventilation and natural lighting • Curtain wall system with green tinted laminated Low E glass • External sunshade to block direct sunlight • Stainless steel weaving sunscreen • Double bank aluminium louvres	• Natural ventilation Open design with effective ventilation • System to enhance air circulation within the building • Big ceiling propeller fan to create wind chill effect at open spaces • Facade wrapped in aluminium and "Low E" laminated glazing • Building design (wall & glass) to maintain a comfortable acoustic environment for occupant • Thermal Storage System	• South and north facing windows, orientations • Triple panel insulated low-E glazing • Custom perforated venetian blinds, low height workstation and glass partitions to create an open well daylit office space	• Natural ventilation • South and north facing windows, orientations • Punch hole window facades in the lower floors, and curtain wall windows with exterior shading louvers in the upper floors • 12mm thick light green tinted window glazing • Insulated lightweight concrete wall, light colour exterior surface of the walls • Electronic air cleaners
Sustainable Site Planning and Management (SM)	• Efficient solution on a very tight and highly constrained site • Vertical greenery to maximize use of the limited space • Roof terrace area filled with greenery	• Roof top landscaped garden. • Located closed to public transportation; LRT station & MRT	• Specific external area for smoking only • Allocated 81% of the 1.7acre (74,052sq ft) of land solely for landscaping	• Green terraced accessible roof	• Creation of a green environment around and on top of the building
Material and Resources (MR)	• Recycle material	• Green tinted laminated Low E glass • Building Integrated Photovoltaics (BIPV) system installed on the roof for energy efficiency	• Reduce indoor air-pollutants by using materials with lesser • Chemical & formaldehyde content for painting & coating	• Not mentioned	• External wall made of 200mm thick aerated concrete blocks with 15mm plaster

Table 1. Design and Features of Green Office Buildings (*continued*)

CRITERIA	• GBI-CERTIFIED BUILDINGS				
	A	B	C	D	E
Water Efficiency (WE)	• Rainwater harvesting system	• Not mentioned	• Rain Water Harvesting system	• Underground rainwater harvesting system • Waste water treatment system to treat the greywater from wash basins, floor traps and ablution to be reused within the building for toilet flushing and landscape irrigation • Low flow fixtures at toilets and ablution	• Rain Water Harvesting system
Innovation (IN)	• Natural ventilation with squarish openings and skylights to promote natural lighting, cool the building, and reduce the use of electricity. efficient Provide creative solution on a very tight and highly constrained site	• Building Automation System (BAS) • Automated Fire Fighting System	• Intelligent Building Management System that will control and monitor security, lighting, fire protection, air-conditioning and climate-control	• Lighting power density and automated control which effectively turns of 40% of the office lights during daytime	• Energy Management System (EMS) monitored by Energy Manager, where the performances of the climatic systems are continuously optimised to meet optimal comfort criteria at least energy cost

Indoor Environment Quality (IEQ)

Passive design features such as building orientation, double skin envelope, sun-shading device, large overhang can be observed in green office buildings. All five sample buildings utilised at least one of these features to allow natural light and ventilation. For example, in building A, building B and building E, the designers use louvered windows at the building façade as one of the green features to block direct sunlight. External sunshade and stainless-steel weaving sunscreen are installed in building B for the same function. Laminated glazing is used in all five GBI certified buildings. Open design in building A and building C enhance air circulation within the building. In addition, big ceiling propeller fan are installed to create wind chill effect at open spaces in building A and building C. In building D, windows are primarily installed to the North and the South orientation with triple panel insulated Low-E glazing and perforated venetian blinds were fitted internally to reduce the heat from thermal radiation. Besides that, low height workstation and glass partitions are arranged accordingly to create an open well daylit office space. In contrast, the vast majority of conventional buildings are designed with insufficient emphasis on passive methods of controlling the indoor environment. Unsurprisingly, a study done by Kanika et al. (2016) found IEQ in green buildings are better than that of conventional buildings.

Materials and Resources

Kuppusamy et al. (2019) defines green building materials as materials, which can be reused, renewed or recycled and can be implemented in the construction without adversely polluting the atmosphere. According to Dodo et al. (2015) the use of green materials such as Volatile Organic Compound (VOC) paint can contribute to reduction in energy consumption and CO_2 emission. In building A, recycled materials are used however types of recycled materials and their position are not mentioned. Building C uses materials with lesser chemical and formaldehyde content for painting and coating to reduce indoor air-pollutants. Building E's external wall is made of 200mm thick aerated concrete blocks with 15mm plaster on both sides which according to Nayak et al. (2018) this material is useful for heat insulation, sound insulation, fire and reduce dead weight. Production of buildings materials released Environmental pollution is critical during the production of building materials in construction industry. Atmospheric pollution, which caused by the cement production whereby the cement factories produce approximately 10 billion tons per year, which is equal to 1/10th global emission and it is considered as a main contributor to greenhouse gases.

Sustainable Site Planning and Management

Construction industry inherently bring negative impact to the environment. Traditionally, environmental impact such dust, emission and odours pollutant from construction activities was not critically considered by the industry players. Natural layout of the area is often neglected to be considered in designing buildings and determining construction method. In order to ensure that construction activities do not harm the environment and benefit the environment and social, GBI certified building adopt sustainable site planning and management construction. Green building must be constructed away from the habitat for any endangered species of flora and fauna. It must not be setting up close to the parkland, wetland, lake, river, stream and tributary which support wildlife and recreational use so that these natural resources are preserved. Undeveloped area may require the construction of new roads, sewer lines, utility poles and any other infrastructure to reach it which lead to other destruction. Therefore, urban area with existing infrastructure and public transportation as well as basic services like bank, hospital, restaurant, fitness centre, post office etc is seen as an ideal place to build a building. It can be observed that all five buildings; PAM building, Menara Worldwide, Menara LGB, Menara Kerja Raya and LEO Building fulfilled are situated in the city where facilities are already available. Besides that, blending open space design with vegetation to the building and its surrounding can reduce the negative impact of building. There is roof top landscaped garden in PAM Building, Menara Worldwide, Menara Kerja Raya and LEO building. There is an allocation of 81% of the 1.7 acre of land solely for landscaping around Menara LGB. This design element is planned at the early stage of the project because improper landscape design can have significant negative effects such as excessive potable water use and erosion.

Water Efficiency

Water efficiency is important features in green buildings. Though Malaysia is a country rich of water with low water tariffs, this wealth must not be taken for granted. Repeated cases such as water pollution especially in Klang Valley has caused water disruption as reported by the media and must be tackled in the design so that water supply is sufficient to cater the needs of the building occupants during the particular bad situation. This problem should be addressed soon to maintain the state of water supply and United Nations Sustainable Development Goals (SDGs) 2030 target, which is to ensure access to clean water and sanitation for all can be achieved. Efficient practices and products, such as rainwater harvesting systems in all green office buildings is adopted in all five buildings studied mainly for irrigation and flushing purpose. For example, rainwater and condensate water in Menara LGB is harvested and recycled for the use of the cooling tower, maintenance of common areas and irrigating the landscapes. It has significantly reduced potable water usage by 52.65%. In addition, greywater from wash basins, floor traps and ablution in Menara Kerja Raya is treated and reused within the building for toilet flushing and landscape irrigation using greywater treatment system introduced to the building. Low flow fixtures at toilets and ablution are also applied. When compared to conventional fixture, low flow fixtures able to reduce water consumption by at least 20%. However, this feature is only applied in Menara Kerja Raya rather than other four sample buildings.

Innovation

Each green buildings practice innovation in the design. Building A emphasis on natural ventilation with squarish openings and skylights to promote natural lighting, cool the building, and reduce the use of electricity. The design is deemed to be an efficient solution on a very tight and highly constrained site. building use of sunshades as a shield allows better energy efficiency throughout the building. Building B adopted automation system (BAS) and Automated Fire Fighting System in the building to fully optimize the energy usage in its building. Building C is equipped with Intelligent Building Management System that will control and monitor security, lighting, fire protection, air-conditioning and climate-control, similar to Building D which have lighting power density and automated control that effectively turns of 40% of the office lights during daytime. Lastly in Building E, Energy Management System (EMS) is adopted to continuously optimise the performances of the climatic systems to meet optimal comfort criteria at least energy cost.

CONCLUSION

Generally, the GBI certified buildings fulfilled all 6 criteria which are Energy Efficiency, Indoor Environmental Quality, Sustainable Site Planning and Management, Materials and Resources, Water Efficiency and Innovation. All the five buildings adopted green features to reduce environment impact of new building. Though the system and materials might be slightly different from one green buildings to another, there are similarities in terms design principal; by incorporating advanced green technologies, sustainable energy solutions, innovative energy management systems and rainwater harvesting systems into the design. Thorough consideration has been given by the project team to produce a building that is environmentally, socially and economically friendly. This is achieved by enhancing good passive designs and integrating active (mechanical and electrical) design and system to deliver and to offer significant long-term comfort and savings for the building owners and occupants. Key participants are expected to have knowledge on the common design criteria incorporated in the green office buildings so that they can act reasonably towards delivering the best green office buildings performance.

REFERENCES

Babu Reddy, Y. (2017). Modern Quantity Surveying- A complete package adding values to projects. http://doi.org/10.13140/RG.2.2.23580.08325.

Kanika, Singh K, Rana K and Dahiya M A (2016). Comparative Study On Green And Conventional Buildings. International Journal of Home Science 2016; 2(2): 338-343.

Krippendorff, K. (2019) Content Analysis: An Introduction to Its Methodology. SAGE Publication Inc.

Kuppusamy, S., Chew, H., Mari, T & CHAI, S. (2019). Implementation of green building materials in construction industry in Johor Bahru, Malaysia. IOP Conference Series: Earth and Environmental Science. 268. 012006. 10.1088/1755-1315/268/1/012006.

Lin, B., Lui, Y., Wang, Z., Pei, Z., & Davies, M. (2016) Measured energy use and indoor environment quality in green office buildings in China. Energy and Buildings. 129, 9-18 Retrieved from Elsevier.

Nayak, G. S., Nanda, S. R. & Sethy, K. (April 2018) Aerated Concrete: A revolutionary Construction Material IJETSR Conference at Hyberabad.

Soon, C., Zaini, Z., Ujang, M., Nagapan, S., Abdullah, A. H. & Hasmori, M. & Rassiah, K. (2017). A Case Study of Green Building in Malaysia: Cost Saving Analysis. Pertanika Journal of Science and Technology. 25. 191-196.

Wan Ismail, W. N., Adnan, H., Yusuwan, N. & Maisham, M. (2018). A Preliminary Investigation on the Effects of Characteristics and Contractual Behaviour on Civil Engineering Project Performance. IOP Conference Series: Earth and Environmental Science. 117. 012040. http://doi.org/10.1088/1755-1315/117/1/012040.

Wan Ismail, W. N. & Adnan, H. (2020). The Influence of Project Characteristics on Contractual Behaviour Of Key Participants In Civil Engineering Projects. Built Environment Journal. 17. 75. doi.org/10.24191/bej.V17i2.9030.

Wan Ismail W.N., Adnan H., Khalil N., Azmi Bakhary N. (2021) Undesired Contractual Behaviour of Key Participants in Civil Engineering Projects. In: Ahmed S.M., Hampton P., Azhar S., D. Saul A. (eds) Collaboration and Integration in Construction, Engineering, Management and Technology. Advances in Science, Technology & Innovation (IEREK Interdisciplinary Series for Sustainable Development). Springer, Cham. doi.org/10.1007/978-3-030-48465-1_100.

Zhang, J., Li, H., Olanipekun, A. O., & Bai, L. (2019). A successful delivery process of green buildings: The project owners' view, motivation and commitment. Renewable Energy, 138, 651–658. doi.org/10.1016/j.renene.2019.02.002.

ASSESSING FINANCIAL RISK IN MANAGING PUBLIC-PARTNERSHIP (PPP) PROJECTS

Nabila Huwaina Ramli[1], Hamimah Adnan[1] and Wan Norizan Wan Ismail[2]
[1]Faculty of Architecture, Planning and Surveying, University Teknologi MARA, Shah Alam, Selangor, Malaysia.
[2]Department of Built Environment Studies and Technology, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA Perak Branch, Seri Iskandar, Perak, Malaysia.

Abstract
The implementation of Public Private Partnership (PPP) initiatives in Malaysia aims to improve the delivery of infrastructure facilities and services for the public sectors. However, there are failure in financial risk due to lack of financial risk control between Government and SPV. This paper aims to identify the financial risk in Public-Private Partnership (PPP) projects. The questionnaire was prepared in Google Form and sent at randomly 80 industry players experienced in PPP projects; however, only 66 questionnaires were answered with an 83 percent response rate. Based on the result and findings, most of the respondents are well experienced on financial risk management in the PPP projects. Risk management knowledge is essential in managing the financial risk on the PPP projects. In term of classification of financial risk, majority of the respondent agreed on the statement of construction cost overruns in PPP projects. It was found that risk analysis, identification and management to deal with uncertainty and unexpected event in term of scope, time, cost, and quality are proposed as the most agreed for financial risk management in PPP projects. The findings of this study may benefit practitioners to further improve financial risk in PPP and its source of financing towards successful PPP projects.

Keywords: *Financial risk; Public-Private Partnership (PPP).*

INTRODUCTION

Public-Private Partnership (PPP) has been increasingly popular over recent years as a mode of procurement over others in order to provide public services and projects faster and more efficiently and cost-effectively (Demirturk, 2019). Zhang et al. (2019) mentions that the public sector aims at maximising public and social objectives, while the private sector aims to maximise its own objectives. In return, Khudhaire et al. (2021) listed that PPP benefits such as lowering public-sector budget deficits and improving the efficiency of the public service. The private sector pays the initial expenses rather than the government for a private financing project.

Wu et al. (2020) stated that the PPP project can fully utilize the benefits of both the government and the private sector and develop a full-scale collaborative relationship between the government and the private company in terms of risk sharing and benefit sharing. However, according to Awodele (2018) PPPs are subject to a variety of risks and different PPP arrangements present different types of risks. As stated by Du et al. (2021), the critical matter are financial risks where the the financial risk factor is the unpredictable risks that might occur during the PPP project implementation, resulting huge impact on project performance. Addressing classification of financial risks and how to manage the financial risk become crucial to the success of PPP project. By considering this issue, this paper aims to identify the financial risk management in Public Private Partnership (PPP) to enhance the PPP projects performance. This paper aims to identify the financial risk factors, determine classification of financial risk and propose the financial risk management in PPP projects.

LITERATURE REVIEW

Public-Private Partnership (PPP) Projects in Malaysia

Public-Private Partnership (PPP) is the government- private sector engagements and is a globally accepted public sector procurement mechanism. When the private sector provides public services or facilities, a certain level of responsibility must be transferred to the private company by the Government. PPPs are described by Malaysia's Prime Minister's PPP Department as projects which received funding from a private company through a project finance scheme. Constructing, managing, maintaining, repairing and replacing assets of the public sector such as building, infrastructure, equipment and equipment as mentioned by Wu et al. (2020) is a type of public-private collaboration in which a stand-alone project business is developed, funded, and managed by the private sector. According to Ahmad et al. (2018), PPP is a contractual arrangement between companies to attain similar objectives or mutual advantages while sharing resources and obligations. Hasan et al. (2021) described that this collaboration between the public and private sectors has the following benefits: enhancing performance in operational and maintenance, supplementing government funding for project execution with additional sources of revenue, and providing a balanced environment for risk allocation between the private and public sectors and enabling access to cutting-edge planning, management, and service delivery skills during operation and maintenance. The government pays the private partner rent for the developed facility and public services under this agreement. There are several forms of PPP in Malaysia include Build Operate Transfer (BOT), Build Lease Maintenance & Transfer (BLMT), Build Own Operate (BOO), Build Lease & Transfer (BLT) and Land Swap.

Financial Risk Factors in Public-Private Partnership (PPP) Projects

Hu et al. (2021) explained that many unpredictable elements confront the project implementation organisation during the PPP project implementation as the PPP development phase will be influenced and interfered with by a variety of financial risk factors. Capital constraints, pressures in economic development requiring additional facilities and avoid public investment restrictions as listed by Ahmad et al. (2017) are the key driving drivers for PPP adoption. The empirical study conducted by Su & Hu (2020), project funding is the major risk factor in the construction industry. Project financial for the PPP Project entails the complicated development of the optimal structure of funding sources such as bank loans, equity, shares, financial leasing, corporate loans, bonds, etc.

A scarcity of high quality experts as mentioned by Yiu et al. (2018) is one of financial risk factor in PPP projects. Ali & Oudat (2020). stated that failures when involving private sector in PPP projects necessitate the parties to carefully planning, calculating, and forecasting costs and revenue close to reality, adjusting compliance with the contractual agreements, complying with regulations, and increasing transparency. Lack of quality experts is seen as a big risk factor by Tamošaitienė et al. (2021), it not only results in poor work performance but also impact construction delays, and increased expenditures in PPP projects. Because of the lack of professional knowledge and experience in facilities operations and management Liu et al. (2021) stated that PPP model operations and maintenance often are excessive and cost effectiveness of resource allocation is low, leading to a failure and additional cost in the implementation of PPP projects.

In PPP project, site condition is also considered as financial risk factor as Rybnicek et al. (2020) stated that risk associated in with the unpredictable incidents with a challenging environment is common issue in the construction site. According to Tamošaitienė et al. (2021), contractors are accountable for critical risks for changing site conditions such as geological conditions, natural disasters, and access issues on construction sites.

Classification of Financial Risk in Public-Private Partnership (PPP) Projects

Construction projects, as described by Denicol, J., Davies, A., & Krystallis, I. (2020), are unpredictable, high-risk dynamic, and change-prone, and they usually fail to meet their objectives. PPPs, according to Casady et al. (2020) are subject to a variety of risk. Different form of risks are associated with different PPP agreements. As a result, Ali & Oudat (2020) and Onsongo et al. (2020) mentioned that financial risks are an important issue to consider when evaluating a company's performance.

According to Matsumoto et al. (2021), PPP do not eliminate project risks but it brings a business-oriented implementation partner that is to implement them with recourse to the financial markets. Risk in financial market such as changes in market demand, interest rate and inflation are adverse factors in PPP projects according to the research done by Nguyen et al. (2020). Other than that, high taxation risk and high insurance cost also can impact on financial in PPP projects. OECD (2017) suggested that an affiliate's taxable profits should be regulated by the three value drivers: the project objective implemented, the assets that employed and the risk bears.

In PPP project, parties might experience costly legal settlement. It is significant legal settlement costs that can have an influence on project financing. Casady et al. (2020) proposed, in a major context, that the PPP stakeholders should give special attention to the financial components of the crisis that are likely to be challenging and contentious. Insufficient financial audit can impact the financial risk in PPP projects as Mario et al. (2020) found that auditors can delve deeper into hidden data to monitor the company's financial risks and increase the quality and accuracy of financial transparency. It is difficult to guarantee the accuracy of financial information. Thus, financial data errors as mentioned by Wanget al. (2020) can be considered as one of the risks that can effect project expenditure. Henceforth, financial risk in PPP project are soaring permit and license expenditure, high bidding & tendering cost and excessive termination cost. Wolfstetter (2021) stated that PPP bids includes a premium as compensation for project risk. It also involved high consulting and professional fees. This will result the procurement unduly expensive.

In PPP project, according to Nguyen et al. (2020), changes or flaws in a design, inadequate designs, and difficulties in adhering to the standards of the client's requirements was often reported that impact the financial risk. Since requirement of the PPP project are unclear, they may need to be adjusted during the implementation of a project. Subsequently, PPP has an impact on SPV's excessive operational costs because it typically involves a structured and multiple set of supervising, controlling, and monitoring activities. Moreover, Akawi & Musonda (2021) stated that the absence of a pricing frame for health and safety components in PPP projects makes it difficult to manage health and safety expenses correctly and adequately that lead to financial risk.

In addition, the lack of government guarantees may have low funding available to the project and can directly increase the cost of funding the project, as Rezouki & Hassan (2019) pointed out that guarantee funds are best used to attract private funding for projects where certain risks are controlled by government, such as the political and regulatory risks that cannot be taken into consideration by a market. Therefore, Acheamfour et al. (2019) explained that financial status is one of the key factors, since a financially stable contractor is essential to improve the possibility of PPP project success. Completing within the contractually agreed cost is one of the criteria of a successfully delivered PPP projects Durdyev et al. (2017). However, Brüggen & Luft (2016) mentioned that PPP projects often face construction cost overruns.

Financial Risk Management in Public-Private Partnership (PPP) Projects

Mohammadnazar & Samimi (2019) explained that financial risk management in in Public-Private Partnership (PPP) Projects comes to identify the loss risk, followed with reasonable efforts to study the potential hazards on the financial outcomes of a certain financial entity. Financial hazards, which are essential to the outcome of a company, require further research (Ali & Oudat, 2020 and Onsongo et al., 2020). Financial risk can affect the performance of PPP projects in the Malaysian construction industry. To limit the financial risk, an efficient approach of managing risk must be established.

The transfer of risks to the private sector in PPP projects was one of the government's key objectives. The concessionaire must be financially able as financial capabilitity is crucial as mentioned by Noja et al. (2021) to begin the project strongly during the entire concession period. Financial performance is strongly considered as mentioned by Băndoi et al. (2021) demonstrates how financially sound a company is, particularly in terms of cash flow.

Risk management strategy delivers the most efficient, accurate and organised financial risk management decision support tool in construction projects Subramanyam & Iswarya (2018). A financial audit is essential in order to mitigate the financial risks. Suciu, Marta-Christina, Gratiela Georgiana Noja, and Mirela Cristea (2020) revealed that a financial audit resilience strategy and long-term planning for the financial risk control in the PPP Project were necessary to be implemented. The success of the project depends on the tracking of critical project risks and core costs and time intervals variables. According to Shubina & Ivanov (2020), parties should therefore strive for quality of work and team-friendly financial risk-sharing in order to maintain a balance in risk transfer. Before the project commence, Šuman et al. (2020) revealed that the parties involved should track and plan their financial cash flow by implement advanced technology and techniques (Owolabi, 2018) for assessing, estimating, and ranking financial risk such as suggested by Šuman et al. (2020), Cost Benefit Analysis (CBA), Value for money and Payback Period to avoid increasing on the cost of operations that lead to financial risk.

From a business standpoint, the manner PPP deals are financed is essential to the PPP initiative. It is absolutely important if expected returns for investors were achieved in reality and whether a PPP agreement was financed by debts or by banks. Wang et al. (2020) suggest that government incentives are important to broader financial mechanism that can support the PPP project’s programme. Other than that, a government guideline is required to improve a good financial plan. According to Kumar et al. (2018) and Chen et al. (2017), Governments enacted measures to limit the profits of private investors during the project's concessionary period. This includes developing a stringent practical policy to guide private investors and project managers toward profit control. Even though the project risk have been transferred to private companies in PPP, it is still the client's responsibility to supervise the overall performance of the project in terms of resources, schedule and quality in order to avoid project failure.

In order to avoid inaccurancies in financial data relating to project financing, it is critical to enable staff to communicate financial risk issues with consultants and concessionaires for discussion as according to Hueskes et al. (2017), achieving project goals in a PPP project is hampered by a lack of contract clarification, relationship risk and inaccurate cost estimation. A proper risk sharing as stated by Biygautene et al. (2019), represent a major attribute of well-developed public entities managerial and technical competence. Allocating anticipated risk to the best able to manage and control them is the only way to achieve value for money.

Mathew & Lal (2021) suggested that risk analysis, identification and management shall address in terms of scope, time, cost and quality uncertainty and unexpected events to attain the project's financial objectives. A financial risk assessment must be performed in order to identify management weaknesses and improve financial risk management skills. To successfully complete the PPP project, detailed financial clarity, relationship risks, and precise cost estimation must be investigated. Hu et al. (2021) stated that it is vital to remember that many forms of risk might adversely affect the financial performance of the PPP projects.

METHODOLOGY

This research presents the findings of the main survey, which adopted the quantitative approach via questionnaire survey. The quantitative methodology involved questionnaires were sent out to 80 industrial players involved in PPP projects. However, only about 83% had responded to this questionnaire. The data gathered from the questionnaire surveys were analysed using descriptive analysis and calculated in the Social Sciences Statistical Package (SPSS) software.

RESULT AND DISCUSSION

Respondent's Demographic

Section A concentrates on demographics, which are analytical characteristics of individuals used to ascertain the backgrounds of respondents. The demographic data gathered from questionnaire which were compiled from the participants consists of working experience, sector of organization, position of the respondents, company's main business and involvement in PPP projects. The questionnaire was distributed via email and LinkedIn received 66 responses from client, architect, engineers, quantity surveyors and contractors. The questionnaire was employed in this study and the selection of respondents was participated by whom that directly involved in PPP projects. Table 1 present the summary of the respondents' demographic information.

Table 1. Demographic Background of Respondents

	Item	Sub-item	Frequency	Percentage(%)
1	Working experience	Less than 2 years	0	0
		2 to 5 years	10	15
		5 to 8 years	24	36
		More than 8 years	32	49
2	Sector of organisation	Government	15	23
		Private concessionaires	51	77
3	Position	Public Client	6	9
		Architect	5	8
		Civil & Structural Engineer	3	4
		Quantity Surveyor	27	41
		Mechanical & Electrical Engineer	2	3
		Contractor	23	35
4	Company's main business	Building Work	49	74
		Infrastructure Work	38	58
5	Involvement in PPP projects	Yes	66	100
		No	0	0

Table 1 shows that 100% of participants experienced involvement in PPP projects and 77% of them are from private concessionaire with 23% are from the government. 27 of respondents were quantity surveyors, 23% were contractors, 6% were public clients, 5% were architects and 3% of civil &structural engineers. The lowest recorded percentage is 2% mechanical & electrical engineers. Most of participants in the survey are expert in PPP projects where 85% of participants have the experience in the PPP Projects of above 5 years and more than 8 years. The remaining 15% of participants have 2 to 5 years of experience.

Financial Risk Factors in Public-Private Partnership (PPP) Projects

Table 2. Ranking and Mean Score

Rank	Mean	Financial Risk Factors in Public-Private Partnership (PPP) Projects
1	4.7	Project funding
2	4.32	Project operation and maintenance
3	4.25	Lack of high quality experts
4	3.97	Site condition

Table 2 shows the ranking and mean score for the financial risk factors in PPP projects, and it was discovered that the majority of respondents agreed on 'project funding', which obtained the best mean of 4.70, followed by the statement of project operation and maintenance and lack of high quality experts with the mean value of 4.32 and 4.25 respectively. The least agreed risk factor is site condition with the mean value of 3.97. Hasan et al. (2021) stating that the main financial risk factor is funding for development as for implementing PPPs are to reduce the government's budget constraint inherent problem and to allow for shared risk because the private sector has broader coverage when it comes to financing, building, managing, and maintaining assets, and delivering services.

Classification of Financial Risk in Public-Private Partnership (PPP) Projects

Table 3. Ranking and Mean Score

Rank	Mean	Classification of Financial Risk in Public-Private Partnership (PPP) Projects
1	4.95	Construction cost overruns
2	4.94	High bidding and tendering cost
3	4.7	Excessive cost of operation
4	4.39	Unfair share and profit
5	4.36	Inadequate investing capital to initiate project
6	4.32	Increased consulting and professional fees
7	4.17	Changes in interest rates on borrowed funds
8	4.11	Changes of market demand
9	4.03	High cost on design projects
10	4.03	High inflation cost
11	3.97	Weak financial market
12	3.92	High expenses on occupational safety & health
13	3.88	High insurance costs
14	3.86	Soaring permit and licenses expenditure
15	3.82	Insufficient financial audits
16	3.79	Soaring concession fees
17	3.73	Costly legal settlements
18	3.68	Soaring market risk
19	3.68	Lack of government guarantee
20	3.67	Significant error in the financial data for project funding
21	3.33	Excessive contract termination/ cancellation cost.
22	3.08	High financial compensation against Force Majeure
23	2.95	High taxation risk
24	2.6	Client's inability to service debt

Table 3 presents the ranking and mean score for classification of financial risk in Public-Private Partnership (PPP) Projects and it was found that the majority of the respondents agree that the 'construction cost overruns' received the highest mean, which is 4.95. This is supported by Khudhaire & Naji (2021), construction risks are primarily related to cost overruns, which will have an impact on the project's profitability by increasing construction and financing costs. Du & Gao (2021) identified schedule delay, poor planning and scheduling, and frequent design changes as the most significant cost overrun factors. Cost overruns as stated by Biygautene et al. (2019) and Du & Gao (2021) are include cost understatements in initial project proposals and project commitment escalation when initial total costs turn out to be higher than expected.

Following by the statement of high bidding & tendering cost and excessive cost of operation with the mean value of 4.94 and 4.70 respectively. Meanwhile, the statement like excessive contract termination/ cancellation cost with the mean value of 3.33, high financial compensation against Force Majeure with the mean value of 3.08, high taxation risk with the mean value of 2.95 and client's inability to service debt with the mean value of 2.60 are the bottom five which their mean value are the least among other possibilities of occurrence of financial risk in PPP projects.

Financial Risk Management in Public-Private Partnership (PPP) Projects

Table 4. Ranking and Mean Score

Rank	Mean	Financial Risk Management in Public-Private Partnership (PPP) Projects
1	4.82	Risk analysis, identification and management to deal with uncertainty and unexpected event in term of scope, time, cost, and quality.
2	4.71	Detail financial clarity in the contract, relationship risks and accurate cost assessment
3	4.68	Parties involved should track and plan financial cash flow prior to project commencement.
4	4.64	Both parties have to ensure the quality of the work delivered within the time, cost and quality
5	4.62	Implement efficient financial audit towards better risk management practices
6	4.52	Parties involved should work toward team-friendly financial risk sharing
7	4.26	Create adequate regulatory framework to be implemented in PPP project
8	4.18	Allow advanced technology to initiate the project to avoid increased cost of maintenance
9	4.17	Allow employees to take part in communicating for discussion of financial risk issues with consultant and concessionaire to avoid errors in financial data
10	4.17	Practice proper planning and scheduling for financial transfer to reduce financial risk
11	4.16	Government incentive to broader financial mechanisms that can support the country's PPP program
12	4.14	Government must have financial capability to service debt.
13	4.12	Allow usage of techniques for assessing, estimating and ranking financial risks to such as Cost Benefit Analysis(CBA), Value for Money (VFM), Payback Period etc
14	4.08	Transferring risk to insurance company if any accident or incident happened in PPP projects
15	4.06	Concessionaire must have strong financial capability to initiate the project throughout the concession period
16	3.89	Guideline from the Government(from Unit Prime Minister Department) to enhance good financial plan

Table 4 presents the ranking and mean score for financial risk management in PPP projects. It can be seen that risk analysis, identification and management received the highest mean value of 4.82 where the scope, time, cost, and quality plays an important part of the financial risk in PPP projecgs. Oehmen et al. (2020) agreed as financial risk management is defined as a codified process for identifying and evaluating risks, as well as identifying management strategies and how to cope with them. Owolabi (2018) suggested that the responsibilities and risks identified into a risk breakdown matrix, then assessed the risk associated with each task by taking into account each subgroup of financial risk, determining its probability of occurrence and impact. According to Memon et al. (2020), after determining which potential risks are critical, the risk manager must determine which risk management actions to take to treat the risk.

CONCLUSION

It can be concluded that knowledge from expert is essential in proposing financial risk management for PPP projects. It was found that the major financial risk factors that were highlighted in the findings are construction cost overruns, high bidding and tendering cost and excessive cost of operations. It was proposed that financial risk management are the process for determining, assessing, consent to or reducing ambiguity in decisions making to assess the financial risk. It was suggested that the financial risk management involved risk analysis, identification and management as it imvolved with uncertainty and unexpected event in term of scope, time, cost, and quality. Furthermore, detail financial clarity in the contract, relationship risk and accurate cost assessment to enhance the good financial plan were recommended as financial risk management in PPP project. Most of the respondents also agreed that parties involved should track and plan financial cash flow prior to project commencement as one of the financial risk management for PPP projects' success.

REFERENCES

Adedokun, O. a., Ibironke, O. T., & Babatunde, S. O. (2013). Assessment of competitive tendering methods of procuring educational building projects in Nigeria. Journal of Facilities Management, 11(1), 81–94. https://doi.org/10.1108/14725961311301484.

Acheamfour, V.K., Kissi, E., Adjei-Kumi, T.(2019). Ascertaining the impact of contractor's prequalification criteria on project success criteria. Engineering. Construction and Architectural Management, 26(4).

Ahmad, U., Ibrahim, Y. B., & Bakar, A. B. A. (2018). Malaysian public private partnership. Academy of Accounting and Financial Studies Journal, 22, 1.

Ahmad, U., Ibrahim, Y., & Minai, M. S. (2017). Public private partnership in Malaysia: The differences in perceptions on the criticality of risk factors and allocation of risks between the private and public sectors. International Review of Management and Marketing, 7(2), 138–150.

Akawi, J., & Musonda, I. (2021). Costing of Health and Safety Elements in Construction Projects in Gauteng, South Africa. In Collaboration and Integration in Construction, Engineering, Management and Technology (pp. 315-320). Springer, Cham.

Ali, B. J., & Oudat, M. S. (2020). Financial Risk and the Financial Performance in listed Commercial and Investment Banks in Bahrain Bourse. International Journal of Innovation, Creativity and Change, 13(12), 160-180.

Awodele, O. A. (2018). Assessment of Risks Involved in Housing Projects Procured using Public Private Partnership System in Nigeria. International Journal of Economics, Commerce and Management, 6(12), 443- 455.

Băndoi, A., Bocean, C. G., Del Baldo, M., Mandache, L., Mănescu, L. G., & Sitnikov, C. S. (2021). Including Sustainable Reporting Practices in Corporate Management Reports: Assessing the Impact of Transparency on Economic Performance. Sustainability, 13(2), 940.

Biygautene, Mhamed, Christina Neesham, and Khalid Othman Al-Yahya. (2019).”Institutional Entrepreneurship and Infrastructure Public- Private Partnership (PPP) : Unpacking the Role of Social Actors in Implementing Public – Private Partnership (PPP): Unpacking the Role of Social Actors in Implementing PPP Projects.” International Journal of Project Management 37 : (192 -219).

Brüggen, A., & Luft, J. L. (2016). Cost estimates, cost overruns, and project continuation decisions. The Accounting Review, 91(3), 793-810.

Casady, C. B., Eriksson, K., Levitt, R. E., & Scott, W. R. (2020). (Re) defining public-private partnerships (PPPs) in the new public governance (NPG) paradigm: An institutional maturity perspective. Public Management Review, 22(2), 161–183.

Chen, R., Wang, C. and Fang, Y. (2017), “An unfair option game : the effects of asymmetric government subsidy to innovators and immitators”, Eurasia Journal of Mathematics, Science and Technology Education, Vol.13, No. 12, pp. 7845-63.

Demirturk Kir, O. (2019). Public Private Partnership Healthcare Projects in Turkey: Strategies For Successful Implementation. (M.S.), Bogazici University.

Denicol, J., Davies, A., & Krystallis, I. (2020). What are the causes and cures of poor megaproject performance? A systematic literature review and research agenda. Project Management Journal, 51(3), 328-345.

Du, L., & Gao, J. (2021). Risk and Income Evaluation Decision Model of PPP Project Based on Fuzzy Borda Method. Mathematical Problems in Engineering, 2021.

Durdyev, Serdar, and Syuhaida Ismail. (2017) "The build-operate-transfer model as an infrastructure privatisation strategy for Turkmenistan." Utilities Policy 48 (2017): 195-200.

Gunduz, M., and Maki, L. (2018). Assessing the risk perception of cost overrun through importance rating. Technological and Economic Development of Economy, 24(5),1829–1844.

Hasan, S., Elwakil, E., & Hegab, M. (2021) Opportunities for Infrastructure PPP Projects in Time of COVID-19-as a Resilience Strategy.

Hu, P., Liu, B., Tan, K., Li, Y., & Zhang, X.(2021) Research on Evaluation Of PPP Project Construction Quality Management Effect Based On Matter-Element Model.

Hueskes, M.,K. Verhoest, and T. Block. (2017). “Governing public-private partnership for sustainability : An analysis of procurement and governance practices of PPP infrastructure projects”. Int. Journal Project Management 35(6).

Khudhaire, H. Y., & Naji, H. I. (2021). Adoption PPP model as an alternative method of government for funding abandoned construction projects in Iraq. In IOP Conference Series: Materials Science and Engineering (Vol. 1076, No. 1, p. 012115). IOP Publishing.

Kioko, C., Olweny, T. & Ochieng, L. (2019). Effect of financial risk on the financial performance of commercial banks in Kenya listed on the Nairobi Stock Exchange. The Strategic Journal of Business & Change Management, 6 (2), 1936 –1952.

Kumar, L., Jindal, A. and Velaga, N.R. (2018). “Financial risk assessment and modelling of PPP based Indian highway infrastructure projects”, Transport policy, Vol.62, pp.2-11.

Liu, D., Mo, W., & Yin, C. (2021). Impact of Rule Governance Mechanism on Project Performance in Public Rental Housing PPP Projects: Control Rights as a Moderating Variable. Discrete Dynamics in Nature and Society, 2021.

Mathew, A. M., & Lal, N. S. (2021). Identification of risk factors leading to cost and time overrun in BOT projects. Sustainability, Agri, Food and Environmental Research, 10(1), 10-10.

Mario Ganau , Helene Cebula, et al. (2020) Surgical preference regarding different materials for custom-made allograft cranioplasty in patients with calvarial defects: Results from an internal audit covering the last 20 years[J]. Journal of Clinical Neuroscience,12-14.

Matsumoto, C., Monteiro, R., Rial, I., & Sakrak, O. A. (2021). Mastering the Risky Business of Public-Private Partnerships in Infrastructure. Departmental Papers, 2021(010).

Mohammadnazar, D. & Samimi, A. (2019). Nessacities of Studying HSE Management Position and Role in Iran Oil Industry, Journal of Chemical Review, 1(4), 252-259.

Memon, A. A., Malek, M. S., & Patel, A. (2020). A Review on Risk and Risk Management Technique in Construction Projects. International Journal of Disaster Recovery and Business Continuity Vol.11, No. 1, pp. 2695–2701.

Nguyen, N., Almarri, K., & Boussabaine, H. (2020). A risk-adjusted decoupled-net-present-value model to determine the optimal concession period of BOT projects. Built Environment Project and Asset Management.

Noja, G. G., Thalassinos, E., Cristea, M., & Grecu, I. M. (2021). The Interplay between Board Characteristics, Financial Performance, and Risk Management Disclosure in the Financial Services Sector: New Empirical Evidence from Europe. Journal of Risk and Financial Management, 14(2), 79.

OECD (2017) "OECD Transfer Pricing Guidelines for Multinational Enterprises and Tax Administrations 2017".

Oehmen, J., Günther, A., Herrmann, J. W., Schulte, J., & Willumsen, P. (2020). Risk management in product development: risk identification, assessment, and mitigation–a literature review. In Proceedings of the Design Society: DESIGN Conference (Vol. 1, pp. 657-666). Cambridge University Press.

Onsongo, S. K., Muathe, S., & Mwangi, L. W. (2020). Financial risk and financial performance: evidence and insights from commercial and services listed companies in Nairobi securities exchange, Kenya. International Journal of Financial Studies, 8(3), 51.

Owolabi, H. (2018). Public accountability : The case of government guarantee scheme in PFI /PPP projects (Doctoral dissertation, University of the West in England).

Rezouki, S. E., & Hassan, J. K. A. (2019). An evaluation of barriers obstructing the applicability of Public Private Partnership (PPP) in infrastructure development. Civil Engineering Journal, 5(12), 2643-2664.

Rybnicek, R., Plakolm, J., & Baumgartner, L. (2020). Risks in Public–Private Partnerships: A Systematic Literature Review of Risk Factors, Their Impact and Risk Mitigation Strategies. Public Performance & Management Review, 43(5), 1174-1208.

Samimi, A. (2020). Risk Management in Information Technology. Progress in Chemical and Biochemical Research, 130-134.

Shubina, T., & Ivanov, A. (2020). Financial Models of Public-Private Projects. In 8th International Conference on Contemporary Problems in the Development of Economic, Financial and Credit Systems (DEFCS 2020) (pp. 55-60). Atlantis Press.

Stosic, B., Mihic, M., Milutinovic, R., & Isljamovic, S. (2017). Risk identification in product innovation projects: new perspectives and lessons learned. Technology Analysis & Strategic Management, 29(2), 133-148.

Su, B., & Hu, Q. (2020). An empirical study on the key success factors of ppp-based PCA in the big data environment--a case study of China. In E3S Web of Conferences (Vol. 214, p. 01010). EDP Sciences.

Suciu, Marta-Christina, Gratiela Georgiana Noja, and Mirela Cristea. (2020). Diversity, social inclusion and human capital development as fundamentals of financial performance and risk mitigation. Amfiteatru Economic 22: 742–57.

Subramanyam, B., & Iswarya, R. (2018). Troubled Projects in Construction Due To Scant Risk Management. International Journal of Engineering & Technology Website:, 7(3.12), 322–325.

Šuman, N., Marinič, M., & Kuhta, M. (2020). A methodological framework for sustainable office building renovation using green building rating systems and cost-benefit analysis. Sustainability, 12(15), 6156.

Tamošaitienė, J., Sarvari, H., Chan, D. W., & Cristofaro, M. (2021). Assessing the Barriers and Risks to Private Sector Participation in Infrastructure Construction Projects in Developing Countries of Middle East. Sustainability, 13(1), 153.

Wang, X., Lai, J., Qiu, J., Xu, W., Wang, L., & Luo, Y. (2020). Geohazards, reflection and challenges in mountain tunnel construction of China: a data collection from 2002 to 2018. Geomatics, Natural Hazards and Risk, 11(1), 766-784.

Wolfstetter, E. G. (2021). Universal High-Speed Broadband Provision: An Alternative Policy Approach.

W. Wu, Y. Liu, C. H. Wu, and S. B. Tsai. (2020) “An empirical study on government direct environmental regulation and heterogeneous innovation investment,” Journal of Cleaner Production, vol. 254, Article ID 120079.

Yiu, N. S., Sze, N. N., & Chan, D. W. (2018). Implementation of safety management systems in Hong Kong construction industry–A safety practitioner's perspective. Journal of safety research, 64, 1-9.

Zhang, B., Zhang, L., Wu, J., and Wang, S. (2019). Factors affecting local governments' public–private partnership adoption in urban China. Sustainability 11:6831. doi: 10.3390/su11236831.

BUILDING INFORMATION MODELLING (BIM) IMPLEMENTATION AND JOB PERFORMANCE

Ani Saifuza Abd Shukor[1], Azzri Fazril Rosman[2], Shamsida Saidan Khaderi[1] and Anis Sazira Bakri[1]
[1]Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia.
[2]Public Work Department, Kuala Lumpur.

Abstract
BIM is a technology that has a positive implication towards improving project productivity and performance. Implementation of this technology from the early stages is important to maximize the benefits provided by this technology. However, BIM implementation in Malaysia facing a number of issues where the implementation is considered very low and shows a negative sign that this country is still far from the position it is supposed to be. Moreover, there are some issues among professionals involved in this technology. Thus, Construction professionals must deal with several aspects of challenges that include people, technology, policy, and process. The objective of this research aimed to investigate the relationship of BIM implementation on job performance. A quantitative study using the questionnaire was carried out with 242 numbers of professionals that consist architects, engineers and quantity surveyors that serve the Public Work Department (PWD) for public projects. A total population of 242 professionals which consist of architects, engineers, and quantity surveyors involved in public projects were chosen using the stratified sampling method and used as the research sample. The data collection process focuses on fieldwork in primary data collection using research instruments provided through a Google Form. Discussion on research data covers data collection processes, pilot studies, data coding and preparation, data reliability testing, as well as hypothesis testing through multiple regression analysis and analysis of variance (ANOVA). The research findings from the hierarchical multiple regression found that three factors studied, namely human capital, physical capital and relationship capital have a significant positive relationship with job performance. Nonetheless, the research findings are unable to confirm the relationship of organizational capital. This research has implications for the related theories, professionals in the industry, top management, and other researchers.

Keywords: *BIM; BIM implementation; human capital; physical capital; organization capital; relationship capital; influence factors; job performance; public project.*

INTRODUCTION

Malaysia is regarded as one of the world's developing nations and according to Khan et al. (2014), Malaysia's economy must be efficient and successful if it is to achieve developed country status. The construction industry is one of the sectors that contribute to the country's economic development and serves as a vital tool for economic growth. This sector contributes significantly to the aggregation of the economy through revenue generation, capital formation, and employment creation, all of which help to promote the Gross Domestic Product (GDP) and socio-economic development (Khan et al., 2014). However, there are various issues with this industry in terms of time, cost, modifications, waste, and inaccuracy (Samimpay & Saghatforoush, 2020). According to Mohd Nawi et al., there are difficulties such as rework, delay and poor quality. Furthermore, one of the topics highlighted as obstacles in the construction industry is productivity (Mohd Nawi et al., 2009; Gardezi et al., 2014).

As the government recognises the value of BIM, various initiatives have been launched to promote its use in the construction industry (Abd Hamid et al., 2018). Since the adoption of BIM in 2007, the government has made a number of measures to ensure that this technology is implemented in the country. For example, the implementation of BIM is highlighted in the

CITP five-year plan (2016-2020) as a means of enhancing productivity, which will be the primary engine of Malaysia's high income through the adoption of new technology and modern practices (Eadie et al., 2013). This also contributes to the achievement of SDG 9 (Sustainable Development Goal 9) by 2030. In 2021, the government implemented BIM as part of the Public Work Department Strategic Plan 2021-2025, with the goal of increasing BIM implementation to 50 percent in 2021 and 80 percent in 2025 for projects worth more than RM10 million. The government's actions demonstrate that it recognises the relevance and importance of this technology and is committed to improving BIM implementation in the country.

The majority of developed countries are actively implementing BIM. It has become a significant strategy for enhancing task efficiency and effectiveness, which will increase job performance by allowing construction professionals to collaborate on time, cost, and quality (Zainon et al., 2016; Wong et al., 2014). Additionally, the use of this technology resolves various challenges that affect the project's success, such as delays, rework, miscommunication, and other associated issues (Ismail et al., 2017). The features provided by BIM are comparable to the current construction industry's requirements for improving efficiency, effectiveness, productivity, project quality, and minimizing project cost and time delivery (Ghavamimoghaddam & Hemmati, 2017). The Malaysian government acknowledges the benefits of this technology and has undertaken a series of initiatives to promote it in the industry, including several discussions with industry players, roadshows, seminars, workshops, training, and collaboration with universities (Ahmad Latiffi et al., 2014; Ahmad Latiffi et al., 2015; CIDB, 2016).

However, there were some challenges with BIM implementation in Malaysia. People, technology, policy and process are a few of the issues that construction professionals encounter (Jamal et al., 2019). Poor BIM knowledge, financial constraints, lack of awareness of BIM, difficulties in adopting new technology, absence of clear guidelines from the organisation, lack of policies, lack of financial allocation and incentive, and lack of investment in the hardware and software aspects of BIM have been arising in the industry (Othman et al., 2020). Aside from that, there are some concerns among professionals involved in this technology, such as readiness to change, a lack of digital skills, a lack of training and awareness programmes, and a lack of enforcement by local authorities, to name a few (Jamal et al., 2019).

All of the issues that have occurred in the process of implementing this technology have an impact on BIM implementation. Despite the fact that it has been in use in Malaysia for 15 years, this technology remains ineffective (Bui et al., 2016; Kong et al., 2020). It also appears to be limited and not fully effective in terms of time and cost (Kong et al., 2020; Othman et al., 2020; Gardezi et al., 2014). The implementation of BIM in this country appears to suggest that this country is still a long way from where it should be (Roslan et al., 2019; Othman et al., 2020). This is noticeable when the country's Level of Development (LoD) for BIM implementation is limited to Levels 0 to 2 (Zahrizan et al., 2013). Failure to address all of these issues will have an impact on BIM implementation productivity and overall performance (Roslan et al., 2019).

Previous research has identified the factors that have a direct impact on the implementation of BIM in order to maximise output productivity and performance.

Regardless of the fact that BIM's capability has been proven in developed countries, the government considers BIM's implementation in this country to be well behind schedule (Gardezi et al., 2014; Bui et al., 2016; Kong et al., 2020). Due to the sheer importance of BIM, it is necessary to establish a link between BIM influence factors and job performance among the professionals involved.

LITERATURE REVIEW

Building Information Modelling

BIM is a system that provides graphical building representations of structures information that is relevant throughout the project lifecycle, from design to construction, operation, and demolition phase (Eadie et al., 2013). It is a virtual process that incorporates all aspects, disciplines, and systems, allowing stakeholders including owners, architects, engineers, contractors, subcontractors, and supplies to collaborate and integrate with a more accurate and efficient system, resulting in greater efficiency and harmony (Azhar, 2011; Azhar et al., 2008). Design assistance and constructability, scheduling and sequencing, cost estimating, systems coordination, layout and fieldworks, clash detection and reducing uncertainty, and improving efficiency are all benefits of BIM (Memon et al., 2014). Apart from that, BIM can be regarded as a valuable mechanism for visualisation, shop drawing generation and fabrication, code review for authorities, cost estimation, construction sequencing, conflict, interface and collision detection, forensic analysis, and facilities management (Azhar, 2011).

Furthermore, BIM is a technology that was developed to improve the productivity and performance of construction projects (Jamal et al., 2019). This is emphasised in the CITP (2016-2020) five-year plan, where BIM implementation is intended for productivity improvement, which will be the primary engine of Malaysia's high income, through the adoption of new technology and modern practices (CITP, n.d.). In terms of performance, BIM is perceived as a technology that can improve quality performance, resulting in better work, product, and constructability (Memon et al., 2014; Gardezi et al., 2014; Samipay & Saghatforoush, 2020; Fadeyi, 2017). Aside from that, because one of the most prominent issues in the construction industry is time constraints, BIM is considered as a tool that may help reduce working hours while also enhancing work speed (Memon et al., 2014; Samipay & Saghatforoush, 2020; Mohd Nawi et al., 2009). BIM is regarded to be capable of assisting organisations in meeting the expected quantity of work (Gardezi et al., 2014). Nevertheless, in the construction industry in this country, BIM's ability to highlight productivity and performance is not apparent (Kong et al., 2020; Othman et al., 2020; Gardezi et al., 2014).

There are several factors that contribute to the successful implementation of BIM in maximising the technology's benefits. Generally, Sinoh et al. (2020) divided the success factor in BIM implementation into internal aspects (software and hardware, management and leadership, and internal coordination) and external aspects (external coordination). Additionally, Haliburton (2016) identified 15 factors related to BIM implementation and categorised them into three aspects: human capital, software capital, and relationship capital. Commitment and knowledge, digital skills, culture orientation, management support, ICT utilisation, and collaborative synergy are all factors that contribute to BIM implementation (Amuda-Yusof, 2018). Internal factors such as management's attitude, financial aspect, BIM personnel, BIM-related training hours, and external factors such as competitive strength, the influence of other cooperating parties, and influence from competitors, according to Liu and Issa (2010), play significant influence factors on the adoption of BIM. A clear organisational view of the benefits of BIM adoption in terms of increased productivity and efficiency may provide additional government support in meeting the goals (Amuda-Yusof, 2018).

Theory of Job Performance

Two theories, the Resource-Based View (RBV) and Human Capital Theory are highlighted in discussions regarding BIM's performance and productivity. Both theories focused on the aspects that may influence work performance and productivity.

Resource-Based View Theory (RBV)

The Resource-Based View Theory (RBV) considered an organization's resource to be among the most essential factors in determining its comparative advantage level and performance (Barney, 1991). This theory is vital to an organization's management as a step and guideline in building their business from the perspective of resources and capabilities (Dollinger, 1999). RBV suggest that competitive advantage and performance outcomes are the result of firm-specific resources and capabilities that are hard to be duplicated by competitors (Barney, 1991). All the sources are classified into three categories which are physical capital resources, human capital resources, and organisation capital resources (Daft, 1983). Technology, manufacturing, location, and material accessibility are examples of physical capital resources, whereas human capital resources include training, knowledge, experience, judgement, intelligence, and communication. The resources for organisation capital aspects include formal firm reporting structures, planning, control, system coordination, and informal relationships within and outside the firm (Daft, 1983).

Human Capital Theory

The human capital theory is a combination of human and capital, where human refers to the subject that runs economic activities such as production, consumption, and transaction, while capital refers to the factor production that is utilised to create goods or services (Boldizzoni, 2008). Human capital is defined as an individual's knowledge, skills, competencies, and attributes that facilitate the creation of personal, social, and economic value (Rodriguez & Loomis, 2007). Human capital is defined as the key component for improving assets and employees to enhance productivity and gain a competitive advantage (Schultz, 1993). Apart from that, this term refers to the process of training, education, and other professional initiatives aimed at improving an employee's level of knowledge, skills, talents, values, and social assets, resulting in employee satisfaction and, ultimately, improved performance (Marimuthu et al., 2009). Flexibility and adaptability, individual competencies, development of competencies, and individual employability are the four components of human capital (Garavan et al., 2001). The importance of human capital is crucial; as a result, companies and management should devise a strategy for utilising this resource to boost overall performance.

BIM Influence Factors and Job Performance

This study's theoretical framework is built on two research theories: RBV, which emphasises that competitive advantage and performance results are a consequence of firm-specific resources such as physical capital resources (ICT utilisation), human capital (commitment and knowledge), and organisation capital (management support). The human capital theory, which comprises a combination of items including experience, training, intelligence, energy, work habit, and initiative, has also been discussed. Both of these theories suggest how to improve performance by addressing these elements.

In discussing the implementation of BIM, a number of researchers had discussed the factors. The summary is as per on Table 1 below:

Table 1. BIM Implementation Factors

BIM Implementation Factors	Citation															
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1. Human Capital																
Readiness to change	√	√	√						√				√	√		√
Commitment by stakeholder		√		√	√					√			√	√	√	√
Improving skill and knowledge	√	√		√	√				√	√		√	√		√	√
Improve knowledge transfer	√				√				√			√	√			√
2. Organization Capital																
Strong support from management							√	√				√	√	√	√	√
Strong staff development			√	√			√	√	√				√	√	√	
Clear BIM plan implementation			√				√			√		√	√			√
Proper financial allocation							√					√				√
3. Physical Capital																
BIM ICT aspect will save operating cost			√								√			√		
Provide collaboration with stakeholder	√					√	√			√			√			
Increase efficiency work process		√	√		√	√	√		√	√		√	√	√		
The use of BIM ICT will reduce the risk										√		√		√		
4. Relationship Capital																
Improve efficiency by outsourcing													√			√
Maximum benefit by all parties												√	√			√
Clearer communication						√	√			√			√		√	

1: (Sunil et al., 2017), 2: (Abd Hamid et al., 2018), 3: (Roslan et al., 2019), 4: (Babatunde et al., 2020), 5: (Saka et al., 2020). 6: (Mahamadu et al., 2019), 7: (Zainon et al., 2016). 8: (Mengistie et al., 2013); 9: (Tai et al., 2020), 10: (Chen et al., 2018), 11: (Mesaros et al., 2020): 12: (Yuan et al., 2019), 13: (Amuda-Yusof, 2018); 14: (Nfuka & Rusu, 2011), 15: (Liu et al., 2017); 16: (Ibrahim et al., 2019)

Job Performance

Organizations must pay attention to job performance since it has the potential to influence an organization's effectiveness in gaining competitive advantages (Choudhary, Naqshbandi, Philip & Kumar, 2017). Under three metrics, Na-Nan et al. (2018) provided a total of thirteen job performance criteria under three indicators (job quality, job quantity & job time). Tasks performed attentively and correctly, tasks completed as per specifications and standards, materials and tools meet the set criteria and standards, a quality inspection conducted prior to the delivery of goods or services, and products or services meet the expectations of customers are all examples of job quality. Other than that, the items under job quantity involve units of output that are in sync with the number of employees, output unit meets organisational expectations, output unit under the responsibility correspond to the skills and ability, and quantity assignment is always fulfilled. Finally, they highlighted factors under job time which include tasks that are normally completed on schedule, tasks carried out within a reasonable amount of time, delivery of goods or services being conducted in a timely fashion, and workers achieving time-related organisational goals.

Human Capital

The knowledge, expertise, and abilities that build through education and training are referred to as human capital in human capital theory (Marimuthu et al., 2009). This theory emphasises human capital as a major element in improving assets and employees, resulting in higher productivity and competitive advantage (Schultz, 1993). Awareness of each professional in the team towards improving themselves with this aspect is important as it leads to the accomplishment of BIM implementation since it is beneficial which could also improve the control of the project and leads to improvement of the overall performance (Sunil et al., 2017). According to Abd Hamid et al. (2018), improving this knowledge among professionals will lead to a more efficient quality of work in terms of time and cost in delivering the requirements and needs of stakeholders and other construction players. This lead to the following hypothesis:

H1: Human Capital have a significant positive influence on job performance.

Organization Capital

Organization capital is a term used in RBV to describe the resources that comprise formal firm reporting structures, planning, control, system coordination, and informal relationships within and outside the firm (Daft, 1983). Management support was directed toward identifying changes in the competitive environment and reacting in the most efficient and effective manner possible (Manzanares et al., 2020). Some researches have highlighted the importance of this element in improving job performance. This includes Amuda-Yusof (2018), who stated that management support, such as employee training and development programmes, the existence of a BIM competent person in the organisation in creating a referral point, and investment compliance in BIM technology will lead to increased productivity and work performance. Apart from training and seminars, Roslan et al. (2019) stated that having individuals who are knowledgeable regarding BIM and can guide the organisation through the process and flow of implementing BIM will lead to enhanced performance. The most critical success factors in improving the efficacy and efficiency of work are management support through political support, top management commitment, action-oriented development, and resource prioritisation. As a result, the following hypothesis can be stated:

H2: Organization Capital has a significant positive influence on job performance.

Physical Capital

Haliburton (2016) defined physical capital or structure capital as the systems, software, tools, and processes that a company use to create, store, and share knowledge. This capital, in terms of BIM, comprises the use of computers in various processes as well as enhancing the quality of work to enable the construction process from the design stage to the construction stage, allowing team members quick access to the project and improving information flows (Svalestuen et al., 2017). The effectiveness of these physical capital aspects to promote job performance had been noted by some researchers. According to Yuan et al. (2019), the adoption of BIM with interoperability and compatibility can improve and provide a better relationship with overall performance. In addition, the physical aspects, such as software and hardware, are being improved to ensure a smooth implementation and increased output performance. Roslan et al. (2019) support this by highlighting BIM performance graphic capabilities that can improve job smoothness, productivity, and efficiency. Given the relationship discussed by both variables, the next hypothesis to be tested is:

H3: Physical Capital has a significant positive influence on job performance.

Relationship Capital

According to Haliburton (2016), relationship capital in the context of BIM external relationships comprises relations between workers and clients, consultants, and those outside the company. Amuda-Yusof (2018) indicated that there is a need to improve the collaborative aspect among professionals on the outside in order to reduce the risk and challenges of fragmentation in the industry, which will lead to better integration, which will improve the quality and performance of the work produced. According to Liu et al. (2017), improving this relationship aspect will boost work performance in terms of quality, quantity, and time by reducing drafting and related work times, improving the design quality, improving design communication, and improving information quality. This aspect can also be considered as having the ability to improve performance through relationship aspects such as communication, accountability, trust, the culture of the organization, leadership, commitment, and reciprocity. Thus, the relationship between relationship capital and job performance can be asserted as:

H4: Relationship Capital has a significant positive influence on job performance.

METHODOLOGY

This is a quantitative study with the goal of determining the relationship between independent and dependent variables. The data was collected via a questionnaire survey, and the stratified sampling was analysed using descriptive analysis and hypothesis testing. This research focuses on three PWD professionals with experience in BIM implementation for public projects (architect, engineer, and quantity surveyor). These three professionals were chosen as when compared to other professionals, they had the highest percentage of BIM adoption (Roslan et al., 2019). This also applies to their involvement in the BIM project during the pre-contract stage. It is crucial to pay attention to people who have worked on BIM to learn from their experiences and explore their suggestions on BIM implementation.

Sampling

According to Krejcie and Morgans' (1970) table, a sample size of 182 would be required to represent a population of 345 people. Only 242 respondents (70.14 percent) responded to the questionnaire in the quantitative study via a questionnaire survey received by email, which is more than the suggested 180 samples by Krejcie and Morgans (1970). Sample distribution is shown in Table 2.

Table 2. Population and Sample of Research

Professional	*n*	Sample *(Recommended)*	S
Architect	166	63	112
Engineer	119	32	85
Quantity surveyor	60	87	45
Total		**182**	**242**

Notes: *n* is population size; *S* is the sample size
Source: Based on the sample survey

Measures

This study will involve four dependent variables and one dependent variable. The dependent variable for this study is job performance and four (4) independent variables were analysed, namely, human capital, organization capital, physical capital and relationship capital. For all the variables, the respondents are required to rate the variables indicators using a seven-point scale, ranging from "1 strongly disagree" to "7 strongly agree". This study uses '7 scales' of the Likert scale instead of '5 scales' for the accuracy, ease, and a better reflection of a respondent's true evaluation (Finstad, 2010).

Data Analysis

Table 3. Reliability Analysis

Construct	No of Item	Cronbach's Alpha Coefficient (α)
Human Capital	6	0.857
Organization Capital	6	0.912
Physical Capital	5	0.816
Relation Capital	4	0.795
Job performance	13	0.954

Source: Based on a sample survey

Table 4. One Sample Kolmogorov-Smirnov Test

	Kolmogorov-Smirnov Z	Asymp. Sig (2 tailed)
Human Capital	1.103	0.172
Organization Capital	0.925	0.359
Physical Capital	0.900	0.393
Relation Capital	1.293	0.071

Source: Based on a sample survey

Statistical Package for a Social Science (SPSS) program is used to key in and clean the data to correct illogical as well as the omission of the information returned by respondents. Before all the variables were utilized for further analysis, a reliability test was carried out to check the reliability of the data. Table 3 shows Cronbach's alpha for all the variables is higher than 0.7. This indicates the reliability of the data which were used in the model (Nunnally, 1978).

Besides that, Collinearity statistics on Table 4 and the values of tolerance (more than 0.2) shows that there is no absence of multicollinearity problems. After the data is normalized (through the method of two-step transformation to normality), the evidence from the

Kolmogorov-Smirnov test that it is normally distributed and can be analysed through the method of multiple regression. Therefore, the use of regression for subsequent analysis is appropriate.

Comparison Analysis

This study also conducts the analysis of variance (ANOVA). The purpose of this analysis is to compare the mean score of more than two groups, referring to Pallant (2007) who highlighted that this type of variance analysis is suitable to compare the means between the groups and determines whether any of those means are statistically are significantly different from each other.

FINDINGS

Demographic Profile

Table 5. Respondent Demographic

Profile	Engineer (n = 85)		Architect (n = 112)		QS (n = 45)		Overall (n = 242)	
	Total	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**
Gender								
Male	43	50.6	50	42.4	22	48.9	115	47.5
Female	42	49.4	62	57.6	23	51.1	127	52.5
Age								
Below 30 years	11	12.9	19	17.0	18	40.0	48	19.8
30 - 39 year	44	51.8	65	50.8	18	40.0	127	52.2
40 - 49 year	24	28.2	22	19.6	7	15.6	53	21.9
50 and above	6	7.1	6	5.4	2	4.4	14	5.8
Job experience								
Less than 5 years	13	15.3	25	22.3	12	26.7	50	20.7
5- 10 years	19	22.4	42	37.5	18	40.0	79	32.6
More than 10 years	53	62.3	45	40.2	15	33.3	113	46.7
BIM Experience								
Less than 3 years	60	70.6	66	58.9	29	64.4	155	64.0
3- 5 years	20	23.5	37	33.0	16	35.6	73	30.3
More than 5 years	5	5.9	9	8.1	0	0	14	5.7
BIM Use Percentage								
Less than 25	43	50.6	59	52.7	27	60.0	129	53.3
25- 49	18	21.2	18	16.1	7	15.6	43	17.8
50 – 74	19	22.3	27	24.1	8	17.8	54	22.3
75 – 100	5	5.9	8	7.1	0	0	16	6.6

Source: Sample of survey

The objective of the study is to determine the BIM implementation relationship on job performance. To critically analysed the data, all the data, information, and relevant idea are gained from the respondents involved and experience in the BIM implementation. Respondents' profile analysis is conducted using descriptive analysis. The distribution of respondents' profiles can be seen in Table 5. Initially, the respondents were asked about the basic background and brief description of their position in the company's organization. The majority of the respondents had more than five years of experience, indicating a high degree of management and decision-making, implying that the data obtained is reliable and accurate.

Table 6. Result of the Multiple Regression Analysis

Construct	Tolerance	VIF	Model 1				Model 2			
			Engineer (n=85)	Architect (n=112)	QS (n=45)	Overall (n=242)	Engineer (n=85)	Architect (n=112)	QS (n=45)	Overall (n=242)
BIM success factors										
Human capital	0.57	1.753	-0.041	0.103	0.202*	0.125**	-0.05	0.107	0.185	0.112**
Organization capital	0.34	2.937	-0.235*	0.377***	0.076	0.149**	-0.307**	0.294***	0.038	0.074
Physical capital	0.259	3.855	0.477***	0.428***	0.224	0.394***	0.421***	0.204*	0.162	0.277***
Relationship capital	0.321	3.115					0.225*	0.445***	0.173	0.309***
R^2			0.644	0.632	0.632	0.609	0.66	0.703	0.641	0.64
Adjusted R^2			0.622	0.615	0.585	0.601	0.634	0.686	0.584	0.631
R^2 Change			0.644	0.632	0.632	0.609	0.016	0.071	0.009	0.031
Statistics F			28.636***	36.402***	13.389***	73.623***	25.256***	41.499***	11.298***	69.65***

Source: Based on the sample survey (2021)
Significant at: p < .10; ** p < .05; *** p < .01

The analysis of influence factors in the implementation of BIM that affects job performance involves four independent variables (human capital, organization capital, physical capital, and relationship capital). To see the influence of each of these variables on job performance, an analysis through the hierarchical multiple regression method is designed. In the first stage (Model 1) analysis is made on the relationship between three independent variables (internal factors) with job performance. While in the second stage (Model 2), the study included the variable relationship capital (as an external factor) to see the influence of the factor on the relationship of the previous three independent variables with the dependent variable (job performance). A comparative analysis based on data involving three professions (engineer, architect, quantity surveyor) was conducted in addition to the overall analysis.

The results in Table 6 showed that R^2 for all models was in the range from 60.9 percent to 70.3 percent. The higher the R^2 (between 0 to 100 percent), the closer the data to the fitted regression line that represent the variation of a dependent variable explained by the independent variable in the regression model (Fernando, 2020). In addition, the researcher also conducted *F-test* for this study. This test is used to compare the statistical models that had been fitted with the same underlying factors (Kissell & Poserina, 2017). F-test is significant at the significance level of one percent ($p < .01$). The findings of the research demonstrate that all of the independent variables of this study were able to significantly explain the variation in job performance.

Based on Table 6, Model 1 shows that the human capital variables are positive and significant for two data, namely quantity surveyor ($\beta = 0.202$, $p < 0.1$) and overall ($\beta = 0.125$, $p < 0.05$). The architect and engineer, on the other hand, are insignificant. For Model 2 which involves relationship capital variables, the study found that the analysis according to the three professionals (engineers, architects, and quantity surveyors) is not significant. However, the analysis in whole showed a positive and significant coefficient value ($\beta = 0.112$, $p < 0.05$). Based on these findings, the study confirmed H1, which explains that human capital factor among employees involved in the use of BIM can influence their job performance. These findings explain that the higher the human capital factors possessed such as analysing before the actual work is done, involving all stakeholders, emphasizing aspects of education and training, clear information dissemination, and improved skills in the use of BIM, the higher the job performance shown.

The empirical analysis of the relationship between organization capital variables and job performance is also shown in Table 6. Based on the findings in Model 1, the study found that two professionals show a significant positive relationship between organization capital variables with job performance are the engineer ($\beta = -0.235$, $p < 0.1$) and the architect ($\beta = 0.377$, $p < 0.01$). While the survey data for quantity surveyors clearly show that it is not significant. Analysis of the overall data in Model 1 clearly shows that the factor has a significant positive relationship ($\beta = 0.149$, $p < 0.05$) with job performance among those who implemented BIM. Taking the relationship capital variable into account, the analysis of the study in Model 2 clearly shows that engineer ($\beta = -0.307$, $p < 0.05$) and architect ($\beta = 0.294$, $p < 0.1$) have a significant influence on job performance among respondents. While data for quantity surveyor was found to be insignificant to explain the relationship between the two variables. Based on the findings from the overall data, the study was unable to confirm H4. This explains that the level of support including in terms of staff competency development, providing clear planning, and financial allocation from management to improve the effectiveness of the use of BIM in work activities still needs to be improved.

The results of multiple regression analysis on the relationship between physical capital variables and job performance in BIM implementation are also shown in Table 6. For Model 1, the findings of the study empirically show that the two professions, engineer ($\beta = 0.477$, $p < 0.01$) and architect ($\beta = 0.428$, $p < 0.01$) have a significant positive relationship between physical capital variables with job performance. While the analysis of the data for quantity surveyor clearly shows that there is no significant relationship between the two variables. Analysis of the overall data found that the relationship between physical capital variables with job performance was positive and significant ($\beta = 0.394$, $p < 0.01$). The same findings are shown in Model 2, where two professions namely engineer ($\beta = 0.421$, $p < 0.01$) and architect ($\beta = 0.204$, $p < 0.1$) empirically show that there is a significant positive relationship between physical capital and job performance. However, for quantity surveyor, it did not show a significant relationship between the two variables. Based on empirical evidence from the overall data in Model 2 the study concluded that the physical capital factor has a significant positive relationship with job performance ($\beta = 0.277$, $p < 0.01$). Accordingly, the study confirmed H3 which explains that physical capital available in the organization can improve job performance among the staff involved. They are confident that the practice of using BIM can provide various benefits such as saving operating costs, being able to form collaborations with various stakeholders, being able to perform work processes more efficiently, and reducing the risk of failure of a job.

Relationship capital variables are analysed as external factors of the organization that may influence job performance in the BIM implementation for organizations involved in the construction sector. The purpose of the analysis is to see the influence of these variables on the performance of the work of those involved when all three independent variables are controlled as explained previously. In Model 1, the value of $R^2 = 0.644$ for engineers to explain that 64.4 percent of the variation in job performance among those involved in the use of BIM can be predicted from the three variables involved. When the study includes the variable relationship capital in the analysis of the study, it was found that the value of $R^2 = 0.660$, $F(6,78) = 25.256$, $p < 0.01$). These findings explain that when control over all three independent variables was performed, it resulted in R^2 change = 0.016, F change (1, 78) = 3.615, $p < 0.01$. Analysis of study on engineers shows that three variables have a significant influence on job performance. The variables were organization capital ($\beta = 0.307$, $p < 0.05$), physical capital (β = 0.421, $p < 0.01$) and relationship capital (β = 0.225, $p < 0.1$). For the architect, the analysis of the study showed $R^2 = 0.703$, $F(6,105) = 41.499$, $p < 0.01$). This explains, when control is performed on the three variables, it leads to R^2 change = 0.071, F change (1, 105) = 26.285, $p < 0.01$. There are three variables in the architect profession that show a significant positive relationship with job performance, namely organizational capital (β = 0.294, $p < 0.01$), physical capital (β = 0.204, $p < 0.1$) and relationship capital (β = 0.445, $p < 0.01$). Analysis for the quantity surveyor showed $R^2 = 0.632$, $F(6, 38) = 11.298$, $p < 0.01$. When control was performed on the three independent variables involved, it caused R^2 change = 0.009, F change (1, 38) = 0.943, and not significant. No variables show a significant relationship with job performance.

Analysis of the overall data showed $R^2 = 0.609$, $F(6, 235) = 69.650$, $p < 0.01$. Control over the three variables caused R^2 change = 0.031, F change (1, 235) = 20.058, $p < 0.01$. Based on the findings of the study in Model 2, it shows that the relationship capital factor (β = 0.309, $p < 0.01$) has a significant positive influence on job performance. The study confirms H4 which explains that relationship capital factors involve external factors such as reliance on outsourcing, clear communication with all stakeholders in the construction sector, and legislation.

Job Performance Comparison Between Professionals

Table 7. Analysis of Variance (ANOVA)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.867	2	3.934	4.576	.011
Within Groups	205.446	239	.860		
Total Norm Performance	213.313	241			

In making a comparison analysis of job performance between the three-professional involved (engineers, architects, and quantity surveyors) this study analysed a one-way analysis of variance (ANOVA). Based on the analysis in Table 7, it empirically shows that there are significant differences in job performance between the three professions: $F(2, 239) = 4.576$, $p < 0.05$. However, the value of the difference is very small.

Table 8. Post Hoc Tests (Multiple Comparisons)

(I) Professional	(J) Professional	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Engineer	QS	-0.20367	0.17093	0.459	-0.6068	0.1994
	Architect	-.40288*	0.13337	0.008	-0.7174	-0.0883
QS	Engineer	0.20367	0.17093	0.459	-0.1994	0.6068
	Architect	-0.19921	0.16364	0.444	-0.5851	0.1867
Architect	**Engineer**	**.40288***	**0.13337**	**0.008**	**0.0883**	**0.7174**
	QS	0.19921	0.16364	0.444	-0.1867	0.5851

*. The mean difference is significant at the 0.05 level.
Dependent Variable: Job Performance
Tukey HSD

Any possible differences that exist between the three-professional explained through Post Hoc Test comparison using Tukey HSD. The findings of the study are shown in Table 8. Based on the positive mean difference (I-J) and value of significance that must be less than five percent ($p < 0.05$), empirical evidence shows that job performance for architects is higher than engineers. While the comparison of job performance among other professionals showed no significant differences.

DISCUSSIONS

According to the findings of the research, human capital has a significant relationship with job performance. These findings demonstrate the importance of human capital factors in job performance, with the higher these factors are possessed by all parties involved in BIM implementation, the higher job performance will be. This includes adapting current work to BIM methodology, strengthening stakeholder commitment, enhancing education and training, providing clear information on the importance of BIM in the organisation, boosting BIM skills among employees, and improving knowledge transfer to employees. Furthermore, the study's findings indicate that the physical capital aspect has a significant relationship with job performance. This implies that improving the organization's ICT facilities can help employees perform better at work. This involves improving understanding of how BIM can reduce operational costs, promoting stakeholder collaboration, increasing work efficiency, reducing risk, and enhancing the accessibility of ICT support. Higher physical capital factors will lead to better job performance.

Apart from that, the study discovered that organisation capital had no significant relationship with job performance. It reveals that the level of management support has no bearing on the performance of their job. This explains why organisation capital is insufficient, including the level of support such as in terms of staff competency development, clear planning, and financial allocation from management to improve the effectiveness of the use of BIM in work activities. Finally, relationship capital variables are analyzed as external organisational factors that can influence job performance throughout BIM implementation. When all three independent variables are controlled, the influence of the relationship capital aspect indicates that it has a significant positive influence on job performance. Some aspects that encourage this relationship capital aspect include a deeper understanding of BIM's potential in increasing organisational output, use of BIM will ensure all parties get maximum benefit, and the ability of this technology to provide a clearer communication within the stakeholder towards improving job performance factor.

There is only a minor difference between the three professionals. The architect's performance is slightly higher than the engineer's and quantity surveyor's. However, improving the aspect of BIM implementation will lead to increased performance in terms of job quality, job quantity, and job time.

CONLUSION AND RECOMMENDATION

The main objective of this study is to examine the relationship between human capital, physical capital, organization capital and relationship capital. Four hypotheses have been developed: H1: Human capital have a significant positive influence on job performance; H2: Organization capital has a significant positive influence on job performance; H3: Physical capital has a significant positive influence on job performance; H4: Relationship capital has a significant positive influence on job performance. The sample was then analyzed using descriptive and multiple regression analysis. The results revealed that H1, H3 and H4 are supported. This indicates the role of human capital, physical capital and relationship capital have a significant positive relationship with job performance. The findings are consistent with the RBV theory and conclude BIM implementation that has a significant positive relationship with job performance. However, H2 is not supported. Based on the findings of the study, there are several suggestions that should be taken into consideration to enhance the job performance: Improving the level of support including in terms of staff competency development, providing clear planning and financial allocation from management to improve the BIM effectiveness.

FUTURE RESEARCH

This research only focuses on four (4) influence factors of BIM implementation towards job performance. The finding of the research found that $R^2 = 0.64$ which means that all variables investigate represent 64 percent of the total factors towards improving the job performance aspect. Several factors should be included like government initiative (Chen et al., 2018), process factors that include communication and collaboration (Awwad et al., 2020), BIM policy, product information sharing, communication plan (Misron et al., 2018), external factors like government support, and client demand (Awwad et al., 2020). Taking these various factors into account, it is possible to obtain information on various influence factors in BIM implementation that can affect job performance to be more comprehensive.

REFERENCES

Abd Hamid, A. B., Taib, M. M., Razak, A. A., & Embi, M. R. (2018). Building information modelling: challenges and barriers in implement of BIM for interior design industry in Malaysia. In IOP Conference Series: Earth and Environmental Science (Vol. 140, No. 1, p. 012002). IOP Publishing.

Ahmad Latiffi, A., Mohd, S., & Brahim, J. (2014). Building Information Modelling (BIM) Roles in the Malaysian Construction Industry.

Ahmad Latiffi, A. A., Mohd, S., & Rakiman, U. S. (2015). Potential improvement of building information modeling (BIM) implementation in Malaysian construction projects. In IFIP International Conference on Product Lifecycle Management (pp. 149-158). Springer, Cham.

Amuda-Yusuf, G. (2018). Critical success factors for building information modelling implementation. Construction Economics and Building, 18(3), 55-73.

Awwad, Khaled Abu; Shibani, Abdussalam; Ghostin, Michel (2020). Exploring the critical success factors influencing BIM level 2 implementation in the UK construction industry: the case of SMEs. International Journal of Construction Management, ISSN: 1562-3599 (Print) 2331-2327 (Online) Journal homepage: https://www.tandfonline.com/loi/tjcm20.

Azhar, S., Hein, M., and Sketo, B. (2008). "Building information modeling: Benefits, risks and challenges." Proc., 44th Associated Schools of Construction National Conference, Auburn, AL.

Azhar, S. (2011). Building Information Modelling (BIM): Trends, benefits, risks, and challenges for the AEC industry. Leadership and management in engineering, 11(3), 241-252.

Babatunde, S. O., Perera, S., Ekundayo, D., & Adeleke, D. S. (2020). An investigation into BIM uptake among contracting firms: an empirical study in Nigeria. Journal of Financial Management of property and Construction.

Barney, J. B. (1991), "Firm resources and sustained competitive advantage", Journal of Management, 17(1), pp. 99-121.

Boldizzoni (2008). Means and ends: The idea of capital in the West; 1500-1970, New York: Palgrave Macmillan.

Bui, N., Merschbrock, C., & Munkvold, B. E. (2016). A review of Building Information Modelling for construction in developing countries. Procedia Engineering, 164, 487-494.

Chen, Y., John, D., & Cox, R. F. (2018). Qualitatively exploring the impact of BIM on construction performance. In ICCREM 2018: Innovative Technology and Intelligent Construction (pp. 60-71). Reston, VA: American Society of Civil Engineers.

Choudhary, N., Naqshbandi, M. M., Philip, P. J., & Kumar, R. (2017). Employee job performance. Journal of Management Development.

CIDB (2016) The Malaysia Building Information Modelling (BIM) Report.

CITP (n.d.) Construction Industry Transformation Programme 2016-2020: CITP-public.pdf.

Daft, R. (1983), Organizational Theory and Design. New York: West.

Dollinger, M. J. (1999). Entrepreneurship: strategies and resource. New Jersey: Prentice Hall.

Eadie, R., Odeyinka, H., Browne, M., McKeown, C., & Yohanis, M. (2013). An analysis of the drivers for adopting building information modelling. Journal of Information Technology in Construction (ITcon), 18(17), 338-352.

Fadeyi, M. O. (2017). The role of building information modeling (BIM) in delivering the sustainable building value. International Journal of Sustainable Built Environment, 6(2), 711-722.

Finstad, K. (2010). Response interpolation and scale sensitivity: Evidence against 5-point scales. *Journal of usability studies*, *5*(3), 104-110.

Garavan, T. N., Morley, M., Gunnigle, P., & Collins, E. (2001). Human Capital accumulation: The role of human resource development. Journal of European Industrial Training, 25(2/3/4), pp.48-68.

Gardezi, S. S. S., Shafiq, N., Nuruddin, M. F., Farhan, S. A., & Umar, U. A. (2014). Challenges for implementation of building information modeling (BIM) in Malaysian construction industry. In Applied Mechanics and Materials (Vol. 567, pp. 559-564). Trans Tech Publications Ltd.

Ghavamimoghaddam, B., & Hemmati, E. (2017). Benefits and Barriers of BIM Implementation in Production Phase.

Ibrahim, F. S., Shariff, N. D., Esa, M., & Rahman, R. A. (2019). The barriers factors and driving forces for bim implementation in malaysian aec companies. Journal of Advamce Research in Dynamical and Control System, 11, 275-284.

Ismail, N. A. A., Chiozzi, M., & Drogemuller, R. (2017). An overview of BIM uptake in Asian developing countries. In AIP conference Proceedings (Vol. 1903, No. 1, p. 080008). AIP Publishing LLC.

Haliburton, J.T. (2016), Building Information Modelling and Small Architectural Practice: An Analysis of Factors Affecting BIM Adoption, Texas A and M University, Texas.

Jabatan Kerja Raya. (2020). Pelan Strategik JKR 2021-2025 (p. 48). Kuala Lumpur: Jabatan Kerja Raya Malaysia.

Jamal, K. A. A., Mohammad, M. F., Hashim, N., Mohamed, M. R., & Ramli, M. A. (2019). Challenges of Building Information Modelling (BIM) from the Malaysian Architect's Perspective. In MATEC Web of Conferences (Vol. 266, p. 05003). EDP Sciences.

Jurevicius, A. O. (2013). Resource Based View: Strategic Management Insight.

Khan, R. A., Liew, M. S., & Ghazali, Z. B. (2014). Malaysian construction sector and Malaysia vision 2020: developed nation status. Procedia-social and behavioral sciences, 109, 507-513.

Kong, S. W. R., Lau, L. T., Wong, S. Y., & Phan, D. T. (2020). A study on effectiveness of Building Information Modelling (BIM) on the Malaysian construction industry. In IOP Conference Series: Materials Science and Engineering (Vol. 713, No. 1, p. 012035). IOP Publishing.

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

Liu, R., Issa, R. R. A., & Olbina, S. (2010). Factors influencing the adoption of building information modeling in the AEC Industry. In *Proceedings of the international Conference on Computing in Civil and building Engineering* (pp. 139-145).

Liu, Y., Van Nederveen, S., & Hertogh, M. (2017). Understanding effects of BIM on collaborative design and construction: An empirical study in China. International journal of project management, 35(4), 686-698.

Mahamadu, A. M., Mahdjoubi, L., Booth, C., Manu, P., & Manu, E. (2019). Building information modelling (BIM) capability and delivery success on construction projects. Construction Innovation.

Manzanares, Francisco & García-Segura, Tatiana & Pellicer, Eugenio. (2020). Organizational Factors That Drive to BIM Effectiveness: Technological Learning, Collaborative Culture, and Senior Management Support. Applied Sciences. 11. 199. 10.3390/app11010199.

Marimuthu, M., Arokiasamy, L. and Ismail, M. (2009). Human Capital Development and Its Impact On Firm Performance: Evidence From Developmental EconomicS. The Journal of International Social Research, 2(8), pp.265-272.

Memon, A. H., Rahman, I. A., Memon, I., & Azman, N. I. A. (2014). BIM in Malaysian construction industry: status, advantages, barriers and strategies to enhance the implementation level. Research Journal of Applied Sciences, Engineering and Technology, 8(5), 606-614.

Mengistie, Asmamaw & Heaton, Dennis & Rainforth, Maxwell. (2013). Analysis of the Critical Success Factors for ERP Systems Implementation in U.S. Federal Offices. 10.1007/978-3-642-37021-2_15.

Mesároš, P., Mandičák, T., & Behúnová, A. (2020). Use of BIM technology and impact on productivity in construction project management. Wireless Networks, 1-8.

Misron, S. F. M., Abdullah, M. N., & Asmoni, (2018) M. Critical Success Factor of Building Information Modelling Implementation In Facilities Management–An Overview.

Mohd Nawi, M. N., Mohamad Kamar, K. A., Abdullah, M. R., Haron, A. T., Lee, A., & Arif, M. (2009). Enhancement of constructability concept: An experience in offsite Malaysia construction industry.

Na-Nan, K., Chaiprasit, K., & Pukkeeree, P. (2018). Factor analysis-validated comprehensive employee job performance scale. International Journal of Quality & Reliability Management.

Nfuka, E. N., & Rusu, L. (2011). The effect of critical success factors on IT governance performance. Industrial Management & Data Systems.

Nunnally, J. C. (1978). Psychometric theory (2nd ed.). New York: McGraw-Hill.

Othman, I., Al-Ashmori, Y. Y., Rahmawati, Y., Amran, Y. M., & Al-Bared, M. A. M. (2020). The level of Building Information Modelling (BIM) Implementation in Malaysia. Ain Shams Engineering Journal.

Pallant, J. (2007). SPSS survival manual. 3rd ed. Syndey: Ligare Book Printer.

Rodriguez, P. J., & Loomis, R. S. (2007). A New View of Institutions, Human Capital, and Market Standardization. Education, Knowledge & Economy, 1(1), pp.93–105.

Roslan, Ahmad Farhan & Hamid, Zuhairi & Zura, Maria & Zain, Mohd & Kilau, Nurulhuda & Dzulkalnine, Natasha & Hussain, Afifuddin Husairi. (2019). Building Information Modelling (BIM) Stage 2 Implementation Strategy for the Construction Industry in Malaysia.

Saka, A. B., & Chan, D. W. (2020). Knowledge, skills and functionalities requirements for quantity surveyors in building information modelling (BIM) work environment: an international Delphi study. Architectural Engineering and Design Management, 16(3), 227-246.

Samimpay, Rozita & Saghatforoush, Ehsan. (2020). Benefits of Implementing Building Information Modeling (BIM) in Infrastructure Projects. Journal of Engineering, Project, and Production Management. 10. 123-140. 10.2478/jeppm-2020-0015.

Schultz, T.W. (1993). The economic importance of human capital in modernization. Education Economics, 1(1), pp.13-19.

Sunil, K., Pathirage, C., & Underwood, J. (2017). Factors impacting Building Information Modelling (BIM) implementation in cost monitoring and control. In 13th International Postgraduate Research Conference (IPGRC): conference proceedings (pp. 210-224). University of Salford.

Sinoh, S. S., Othman, F., & Ibrahim, Z. (2020). Critical success factors for BIM implementation: a Malaysian case study. *Engineering, Construction and Architectural Management*.

Svalestuen, Fredrik & Candidate, & Knotten, Vegard & Lædre, Ola. (2017). Using Building Information Model (BIM) Devices To Improve Information Flow And Collaboration On Construction Sites. Electronic Journal of Information Technology in Construction. 22. 204-219.

Tai, S., Zhang, Y., & Li, T. (2020). Factors affecting BIM application in China: a social network model. Journal of Engineering, Design and Technology.

Wong, P. F., Salleh, H., & Rahim, F. A. (2014). The relationship of Building Information Modelling (BIM) capability in quantity surveying practice and project performance. International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering, 8(10), 1031-1036.

Yuan, H., Yang, Y., & Xue, X. (2019). Promoting owners' BIM adoption behaviors to achieve sustainable project management. Sustainability, 11(14), 3905.

Zahrizan, Z., Ali, N. M., Haron, A. T., Marshall-Ponting, A., & Abd, Z. (2013). Exploring the adoption of Building Information Modelling (BIM) in the Malaysian construction industry: A qualitative approach. International Journal of Research in Engineering and Technology, 2(8), 384-395.

Zainon, N., Mohd-Rahim, F. A., & Salleh, H. (2016). The rise of BIM in Malaysia and its impact towards quantity surveying practices. In MATEC Web of Conferences (Vol. 66, p. 00060). EDP Sciences.

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EXPLORING AND IMPROVING LATE PAYMENT AND UNDERPAYMENT ISSUES IN THE MALAYSIAN CONSTRUCTION INDUSTRY: AN EXPLORATORY STUDY

Siti Suhana Judi[1] and Nur Emma Mustaffa[2]
[1]Department of Quantity Surveying, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, 40450, Shah Alam, Selangor, Malaysia.
[2]Department of Quantity Surveying, Faculty of Built Environment, Universiti Teknologi Malaysia, 81300 Skudai, Johor, Malaysia.

Abstract
Late payments, underpayments and unnecessary deduction in clients' construction payments are critical issues in the Malaysian and global construction industry. This exploratory study endeavoured to investigate on the issues faced by Malaysian construction stakeholders regarding late and under payments and subsequently addressing them. Qualitative and interpretative methods have been adopted as part of the ultimate aim of the study in understanding why payment issues have arisen in construction projects. Semi-structured interviews were conducted with respondents selected through purposive sampling comprising of private clients and G7 contractors in the Malaysian construction industry. The findings highlighted pertinent issues related to delay claim payment application issues which amongst others include lack of trust between Client and Contractor, contractors' lack of knowledge in variation order (VO) document submission, challenges in providing claim documentation, lack of competent staff, insufficient financial resources, and non-participation in joint payment valuations These delayed payments issues may be addressed by providing competent staff, developing trust between parties, using appropriate contracts, enhancing financial management and external benchmarking. The findings shed light on how to manage payment to avoid entrenched conflict leading to payment being made on time.

Keywords: *Construction; delay; payment; qualitative.*

INTRODUCTION

The construction industry significantly influences the social and economic development of a country. Hence, construction projects are considered based on major investments, prolonged transaction cycles and high-risk factors (Shah, 2016). The prevailing method of conventional payment, such as paying on delivery or one-off payments were deemed unsuitable in construction (Xie, Zheng, Zhang & Li, 2019). Owing to the unique nature of the industry, work completion time and the performance of multiple activities by various skilled or semi-skilled workers could not be generalised (Hussin & Ismail, 2015).

Late payment and underpayment issues are common in the Malaysian construction industry (Abdul Jalil, Jaafar, Mydin & Nuruddin, 2017; Judi, 2020). For example, payment issues delayed project completion, incurred high cost and compromised the quality of the construction projects (Hussin & Ismail, 2015; Judi, Mustaffa & Nayan, 2017). The construction industry involved multiple sub-contractors, suppliers and hirers in construction projects (Abdul Rahman, Ye & Wang, 2014). Late payments and underpayments also triggered cash flow issues for the contractors and sub-contractors working under main contractors.

In practice, clients will stipulate specific payment time lags to protect themselves from the risk of non-completion or poor quality in construction projects (Harmon, 2003; Hou, Liu & Chen, 2011). Payment delays and deductions were means of exercising power over construction project contractors and sub-contractors worldwide (Enshassi & Abuhamra, 2015). Notwithstanding, the payment practices adversely impacted the supply chain and caused disruptions in construction projects (Nyoni & Bonga, 2017). Most sub-contractors at the end of the supply chain are labour-intensive and required timely payment from clients or main contractors to pay the labourers (Soni, Pandey & Agrawal, 2017). Thus, delayed payments and underpayments in construction caused disputes and enhanced the risk of failure in construction projects (Shah, 2016).

Construction industries worldwide experience late payment and underpayment issues, particularly in developing countries (Aryal & Dahal, 2018; Iskar et al., 2019). Exploration on the late and underpayment phenomenon offers an in-depth understanding of the causes of these issues and offers plausible solutions for them from the industry players' point of views.

The current interpretative phenomenological work aimed to investigate the causal components that contribute to late and underpayment issues in the Malaysian construction industry, hence, to recommend proactive practices to reduce payment issues. This approach was used for the purpose of the study in order to achieve the research's ultimate goal. The next section presents literature on payment issues and other relevant barriers in the construction industry. The third section depicts the study's research method, which is based on a qualitative approach, as well as its objectives. The results and discussion are presented in the fourth section, and finally, the results and discussion are presented.

LITERATURE REVIEW

This section primarily reviews the literature on the concept of payment and disputes arising from payment issues in the construction industry. This study has focused solely on privately funded projects because a recent study done by (Mohd Badroldin et al., 2016) found that more than fifty percent (50%) of respondents said that private clients always caused payment problems when compared to government funded projects. The discussion then shifts to interim payment, including definitions from various perspectives, interim payment procedures based on the PAM Standard Form of Building Contract 2018 (With Quantities), and related interim payment issues in the Malaysian construction industry. For the purpose of this study, proactive preventive exploration i.e. (controlling a situation by causing a specific scenario to occur, as opposed to reacting to a situation after it has occurred) is used to aid in the resolution of payment issues before they become disputes and are directed to third parties such as Adjudication. The Construction Industry Payment and Adjudication Act (CIPAA 2012) went into effect in 2014, with the goal of providing quick dispute resolution and relief to unpaid construction industry claimants for work done, as well as facilitating cash flow in the construction industry as a whole (Mazani, Sahab, & Ismail, 2019). The CIPAA 2012 has a promising future in resolving payment disputes between parties in the Malaysian construction industry. The main purpose of these act is to make it easier to make regular and timely payments for construction projects, as cash flow is vital to the completion of work. However, because the aim of this study is to develop a proactive preventive model for payment problems, the CIPA Act is not part of the scope.

The Payment System in the Construction Industry

Payment is basically a contractor's monetary reward in performing or executing an obligation (Shah, 2016). Consequently, failure in timely payment led to a breach in the contract between the parties involved and may lead to disputes (Ali, Manaf, Choy, Hamid & Mahyut, 2015). Payment in the construction industry is categorised as a cascading system (Bagrecha & Bias, 2017). For example, project owners pay the main contractors, who then pay the sub-contractors concerning other sub-parties working under sub-contractors (Enshassi & Abuhamra, 2015).

The clients always delayed payment claims to manage risk factors (Dzulkalnine, Azman & Bing, 2017) and deducted payment from the claims forwarded by the contractors (Ali et al., 2015). Due to the large investment involving construction projects, risk management was deemed necessary. Nonetheless, progress payment ensured timely completion of construction projects and exercised power over contractors and sub-contractors (Cunningham, 2018; Xie et al., 2019).

The complex nature of construction industries is mainly due to the involvement of multiple parties (Shah, 2016). For example, in a typical project, the project owner, the main contractor, consultants, nominated subcontractors, domestic subcontractors, and suppliers are present (Bakhary, Adnan & Ibrahim, 2018). Moreover, the documented complexities of construction industry relationships reportedly caused delays in construction work, prolonged completion time, increase in expanse, and a fastidiousness in quality task completion (Enshassi & Abuhamra, 2015; Harris & McCaffer, 2003).

Payment Disputes in the Malaysian Construction Industry

Given the aforementioned complexities, the projects required the performance of phase-by-phase activities and processes by various professionals (Shah, 2016). Construction projects are exclusively distinct from one another and increased project intricacies (Harris & McCaffer, 2003). The Malaysian construction industry contributes about 8% of the national GDP and offers employment opportunities (Ishak, Alaudin & Ibrahim, 2019). For example, Malaysian private sectors undertake the majority of construction projects amounting to RM 200 billion annually (CIDB, 2017) and offer employment to approximately to 1.0 million people.

Payment application delays occurred due to the verification of claim documentation by the clients' employees (Ishak et al., 2019). Contractors working with sub-contractors also increased operational complications and deferred payment applications (Enshassi & Abuhamra, 2015; Judi et al., 2017). Another pertinent issue concerned the initiation of contract changes by clients and contractors or additional work requiring the completion of construction projects (Abdul Jalil et al., 2017). Moreover, the lack of financial management practices on the clients' end caused delays or non-payment to the contractors. For example, clients simultaneously initiating multiple projects were unable to manage cash flow. The mismanagement occurred at the clients' end and triggered the deferment of payment applications submitted by contractors (Abdul Rahman et al., 2014). Payment delays were triggered by disagreements over unauthorised work valuations beyond the terms and conditions of contracts (Hussin & Ismail, 2015).

METHODOLOGY OF THE STUDY

Research Design

As has been indicated earlier, this qualitative exploration is part of a research with a definitive aim to address the issues on late and non-payment in Malaysian construction projects. The design of the research requires the issues pertaining to late payment and underpayment issues in the Malaysian construction industry be understood, hence, the interpretivism approach was adopted to gauge the insights on payment issues and offers proactive strategies to handle them (Creswell, 2014).

Sampling and Data Collection

The qualitative component of this study focused on the respondents who had been actively involved in the construction sector for more than 10 years, had prior payment-related expertise, and were currently in a top management position or a middle-level management position. The qualitative data were gathered from the main players in the construction industry comprised of G7 contractors (represented as CR) and private clients (represented as CL). The respondents were selected using purposive sampling in line with the aim of the study and designated research questions (Saunders, Lewis & Thornhill, 2012). Furthermore, the data were gathered in-person through semi-structured interview sessions that lasted an average of 1.5 hours per session. Notes and audio recordings were also obtained during the interviews with the interviewees' consent (Creswell, 2014).

For the purpose of this interview, the group of interviewees consist of Clients and G7 Contractor's representatives. In order to encourage participation, potential interviewees were contacted either through email or telephone. The potential interviewees have been briefly explained about the nature and purpose of research and interview conducted. Accordingly, via email and contact through a telephone process, four (4) persons each from the Clients and G7 Contractors expressed their willingness to participate and share their view and opinion on research matters. The details of the interviewees' client background are illustrated in Table 1, while Table 2 tabulates the interviewees' details from the category of G7 contractors.

Table 1. Interviewees' Details (Client)

Code of Interviewees	Interviewee's Position	Experience in Construction (Years)	Experience in dealing with payment claims (Years)
CL01	Senior Manager Head of Project	27	27
CL02	Senior Executive Procurement	10	10
CL03	Senior Project Manager	24	24
CL04	Senior Contract Manager	18	18

Table 2. Interviewees' Details (G7 Contractor)

Code of Interviewees	Interviewee's Position	Experience in Construction (Years)	Experience in dealing with payment claims (Years)
CR01	Senior Quantity Surveyor	10	10
CR02	Chief Executive Officer	11	11
CR03	Managing Director	26	26
CR04	Senior Contract Manager	27	26

Data Analysis

To expedite the process, the interviews were transcript verbatim and analysed by using Atlas.Ti (Version 8) qualitative data software. The content analysis approach was then used to independently perform axial coding (Saunders et al., 2012). Atlas.Ti Version 8.0 was used to conduct thematic content analysis (a qualitative data analysis software enabling the multiple manipulations of extensive qualitative data and enriching research reliability and validity). As a result, the codes were used to establish the emerging categories, which were then developed into themes in order to comprehend the responses of the study subjects (Creswell, 2014). Relevant discussions from the thematic analysis are presented in the following section.

FINDINGS AND DISCUSSIONS

The results of this study will be used to address two of the study's objectives which have been laid down, namely, to examine the causal components and to evaluate the proactive preventive solutions for late payment and under-payment issues in the Malaysian construction industry.

Causal Components of Late Payment and Underpayment Issues

Late payment and underpayment issues in the context of construction projects are the primary concern for delays and incompletion. This study tried to comprehend the causal components of delayed payments. The Oxford English Dictionary (OED Online, 2014) defines the meaning of causal as *"relating to or acting as a cause"* and component is *"a part or element of a larger whole, especially a part of a machine or vehicle".* From the data analysed, there are five significant aspects influencing late payment and underpayment issues in construction projects which include lack of trust, contractors' lack of knowledge in VO document submission, lack of competent staff, insufficient financial resources, and lack of participation in joint project valuations. The following section of the study deliberates on the six significant aspects influencing payment issues.

Table 3. Causal Components of Late Payment and Underpayment Issues

No.	Causal Components	Description
1.	Lack of Trust between Client and Contractor	In general, construction industry clients and contractors do not trust one other.
2.	Contractor's Lack of Knowledge in VO Document Submission	The contractors staff lacked the knowledge to prepare claim documentation based on different client requirements.
3.	Problems in the Providing Claim Documents	Changes in contracts and additional work valuations caused delays in processing claim payments.
4.	Lack of Competent Staff	Contractors lacked competent staff to prepare claim documentation.
5.	Insufficient Financial Resources	Construction clients faced cash flow issues that caused payment delays.
6.	No Participation in Joint Project Valuations	Construction clients and contractors disagreed to joint project valuations and led to contradictions among parties and payment delays.

Lack of Trust between Client and Contractor

Trust is a significant factor in confidence-building among the relevant parties. Additionally, trust inspired faith in the other party's ability to account for delegated responsibilities. The lack of trust resulted in wrong payment claims made by contractors under the clients' name. The respondents from client's representatives articulated the argument as follows:

"For VO works, contractors usually send claims (to the client) that are more than the actual value of work done."

The lack of trust also led to erroneous deductions from the contractors' total claim amount. The clients explained the mentality as follows:

"[clients deducting contractors' claims] is due to clients having the impression that contractors are claiming for more than the actual value of work done."

Interestingly, the contractors were well-versed in the situation. The lack of trust induced the contractors to demand higher payment from clients. The contractors stated as follows:

"We [contractors] will usually submit claims that are a bit more than the actual value of work for on-site development."

Contractors' comprehension level of the issues was obvious. In other words, construction contractors claiming higher amounts as security could still receive the same amount as payment from clients. The contractors argued as follows:

"...the contractor would claim higher as they want to secure…"

Other studies shared similar opinions that contractors tend to make higher payment claims from construction project owners for cash flow. The contractors customarily made higher payment claims from project owners, whereas project owners constantly attempted to deduct the amount claimed by contractors, thus demonstrating a lack of trust between contractual parties. This is apparent as clients assumed that contractors prepared overstated payment claims. On the other hand, contractors' mindset is to charge higher claims as the clients regularly deducted the amount from the payment claims. Hence, the study finding corresponded to the results reported by Abdul Rahman et al. (2014) and Aftab (2014) on lack of trust between contractual parties as one of the major causes of late payment in the Malaysian construction industry.

Contractors' Lack of Knowledge in Variation Order (VO) Document Submission

The parties involved in construction projects need a sound understanding of payment claim procedures. Thorough knowledge of payment procedures prevented conflicts and misunderstandings from arising in the execution of construction projects regarding the variations in projects. According to the client:

"Contractors seem like they do not understand the correct method that is important in getting approval prior to executing additional work."

Another client verified the statement as follows:

"... They [contractors] do not understand the correct procedure if there is a change in job scope."

Although contractors started working with authorised approvals, the right procedures in recording job or project scope changes were often ignored. Non-compliance to proper procedures caused payment delays or non-payment. The contractors submitted arguments on execution errors due to incorrect procedures as follows:

"Different companies have different procedures. Some of them (clients) might want specific documents, such as a drawing and three quotations to compare. The process will always be different. So, these would slow down the process of VOs."

"There is a procedure for additional work that does not adhere to the real procedure... contractors are more technical than contractual."

Non-compliance to the right procedures was attributed to the lack of knowledge and understanding involving contractor staff (Abdul Jalil et al., 2017). Additionally, Nayan, Mustaffa & Judi (2017) furnished similar findings on staff who made payment claims without the adequate understanding to prepare payment claim documentations. Every client required different documentation which resulting in delayed claim preparations and payment applications.

Problems in Providing Claim Documents

Clients encountered situations involving the submission of payment claims without documentary evidence. The client's representatives highlighted the issue as follows:

"Usually, for the purpose of delivering a claim document (whether to claim for additional work or progress payment), contractors always send incomplete documents to the clients."

Similar issues were reported by other respondents as follows:

"The problem in payment for additional work is also caused by contractors since they do not submit a complete document... [contractors] do not provide the before and after pictures as evidence for the additional work they claimed to have done."

Delayed submission of claim documentation was also another issue concerning claim payments. Construction clients reported the case as follows:

"Contractors always take their time to send the application for a payment claim to the consultants (for revision purposes)."

Late payment claims subsequently delayed payments. Nevertheless, contractors viewed the delayed submission of claim documentation from a different perspective. The contractors' perspective was presented as follows:

"As the main contractor, we have to collect all of the claims from all nominated sub-contractors and suppliers. All this collected claim information has to be attached with our claims before they are sent to the clients... this [claim from the sub-contractors] is usually the reason why there is a delay in submitting the claim to clients."

Lack of Competent Staff

Unskilled and incompetent staff also caused payment delays (Omran & Suleiman, 2017). Payment claims needed to be understood in line with the clients' requirements as specific procedural requirements are necessary (Nyoni & Bonga, 2017). Therefore, the lack of professional staff in terms of quality and quantity overloaded the current staff with stress. Contractors highlighted the issue as follows:

"Sources [human capital] at the professional level are lacking... imagine a situation where I am the only Quality Surveyor (QS), and I have to manage 70 sub-contractors... we need more staff to ensure these jobs are done within the time allocated... it is impossible for a QS to complete all the claims for one big project in one month without sufficient staff."

Lack of professional staff (Enshassi et al., 2015; Ishak et al., 2019) indicated that competent and skilled staff are vital for smooth business operations and accurate and timely payment claims from construction clients. The lack of competent and professional staff hindered payment claim preparations and caused unnecessary delays (Soni et al., 2017).

Insufficient Financial Resources

Cash flow management is a grave concern in payment delays to contractors (Judi et al., 2017). From the client's perspective, cash flow relied on the sales made in construction projects (Shah, 2016). Nevertheless, the sale of construction projects is an uneven process. Respondents highlighted the cash flow issue from project sales as follows:

"Clients' cash flow depends on the units sold for each development... if we [clients] cannot sell the units built, we will not be able to roll the money to fund the project."

Contractors also acknowledged the issue and reflected as follows:

"They (the client) may have insufficient cash flow, and maybe the project is not selling well… they use the profit margin here to run other projects, and this will affect the cash flow. Sometimes you spend the cash flow in other places that you are not supposed to."

Cash flow management is critical in the successful completion of construction projects. The improper management of cash flow for multiple projects was highlighted by some contractors as follows:

"The developer (the client) is not financially well-prepared when starting the development… they (the client) would face cash flow problems in which they are not able to pay the contractor on time."

Construction project clients admitted that cash flow is a significant issue in the management of contractor payments. Several clients reflected as follows:

"It is true if the clients have too many ongoing projects at one time... but if the projects do not run smoothly, there will be other problems for the clients to pay the contractors' claims."

"The developer (the client) has eight projects under construction at the same time... this will create problems in managing the money for each of these projects. This does not mean that the developer cannot pay, but financial management is problematic."

The lack of financial management among construction industry players was also reported by Ishak et al. (2019). The major stakeholders found cash flow management challenging and delayed construction projects. The study results resembled Hou et al. (2011) and Soni et al. (2017) findings. Therefore, construction industry players needed to initiate new projects with sufficient funds and planning before beginning new projects.

No Participation in Joint Project Valuation

An additional issue causing payment delays in the absence of projects combined the valuation of both parties (clients and contractors). The respondents observed as follows:

"It is difficult to get the consultant to participate in joint work valuations and works claim variations. Some people were unable to participate in joint valuations and caused delays."

The clients also highlighted the issue of joint valuation as follows:

"If anyone disagrees, there will probably be no joint site valuations, so there will be disputes."

The lack of joint valuations in construction projects was also reported by Soni et al. (2017) and corresponded to the current study findings. Joint valuations enabled the parties to evaluate the project completion stage and the quality of the project under construction (Nayan et al., 2017). Joint valuations promoted trust-building among clients and contractors and empowered the parties to minimise misunderstandings and payment issues.

Proactive Preventive Solutions for Late Payment and Underpayment Issues

This section will discuss on the findings from the interviews with the client's and G7 contractor's representatives on how to proactively prevent the payment problems in the Malaysian construction industry. The Merriam Webster English Online Dictionary (2019) defines the meaning of proactive as "acting in anticipation of future problems, needs, or changes" and Oxford English Dictionary (OED Online, 2015) defines preventive as "designed to keep something undesirable such as illness or harm from occurring" and solution as "a means of solving a problem or dealing with a difficult situation". From a maintenance viewpoint, preventive aspects are associated with payment process that can be anticipated and eliminated before a problem begins to develop. This section presents and discusses the findings from the interviews on how to proactively avoid payment problems in the context of the Malaysian construction industry. For the purposes of this study, six (6) proactive preventive solutions were identified from the interviews conducted to form a proactive preventive solution model as part of the Proactive Preventive Late Payment and Under-payment Issues Solution Model for Payment Settlement.

Table 4. Proactive Solutions for Late Payment and Under Payment Issues

No.	Proactive Solutions	Descriptions
1.	Provide Quality Staff in the Organisation	Having competent and skilled staff at the contractor and clients' end was necessary to reduce unnecessary delays in claim payments.
2.	Develop Trust between Parties	Confidence-building strategies enhanced trust between clients and contractors.
3.	Use Appropriate Contracts	Construction contracts must state the terms and conditions in advance for smooth contract execution.
4.	Enhance Financial Management	Appropriate cash flow and financial management reduced payment delays.
5.	Improve Payment Procedures	Handling payment procedures minimised payment delays.
6.	External Benchmarking	Knowledge acquisition from other successful organisations.

Provide Quality Staff in the Organisation

Competent and qualified staff was required to perform effectively at the organisational level. The higher management is responsible to ensure adequate and skilled staff to function efficiently. Lack of competent staff was discussed by the contractors as follows:

"The duration process for us to set the contract is long. For each megaproject, for instance, it is impossible for one Quantity Surveyor to finish everything within a month. We [the organisation] should have enough staff to get all the work done."

Qualified and adequate staff was required to effectively manage construction projects and payment-related documentation issues (Judi et al., 2017). Staff quality was also highlighted by the clients. For example, the contractors regularly faced difficulties concerning client demands. The clients admitted as follows:

"When the contractor has a contract with a reputable client, they [contractor] should understand the demands of the company [client] to ensure that the claim sent is not rejected [due to submission of incomplete claim documents] and to prevent delays in payment claims made to the contractor."

As payment claim preparation is a technical and cumbersome task (Soni et al., 2017), prompt submission is required by competent and knowledgeable staff. The issue was highlighted by the clients as follows:

"The quality that is looked for in the person in charge is competency as it is one of the ways to deal with issues related to preparing good [and complete] documents."

The same issue was reciprocated by the contractor by stating that:

"The contractor must be competent enough to prove [in matters related to the total amount of the claim made] to the consultant."

Skilled and competent staff is a must for the smooth operationalisation of the construction industry. The qualified and experienced staff could induce the right preparation of payment claims and significantly reduced payment claim delays (Ishak et al., 2019). Regardless, contractors also need to realise that the staff handling payments must be skilled and competent enough to prepare timely and accurate payment claim documentation for the clients (Omran & Suleiman, 2017), thus significantly reducing late payment issues.

Development of Trust between Parties

Trust-building among construction project clients and contractors is necessary to minimise payment issues. The respondents narrated on the lack of trust by highlighting that:

"Even though we are sure that the work done by the contractor is a VO, we [the client] will not pay 100% of the claim for the value of the work done by the contractor due to safety reasons… this is because we as the clients have a perception [the contractor cannot be trusted to make a claim based on the actual work value done] and we do not want to overpay the contractor for VO work."

The construction industry contractors also acknowledged the issue of trust as follows:

"The contractor will [make a] claim higher as they want to be secure… because [the] QS consultant [on behalf of the client] will try to cut the [contractor's] claim."

Furthermore, other participants confirmed the lack of trust among the parties involved. Trust-building strategies have been acknowledged by Nayan et al. (2017) in which the lack of confidence caused significant delays or non-payments following the lack of trust among construction industry parties.

Use of Appropriate Contract

Construction contracts are needed to state the appropriate terms to be understood by relevant parties. This has been deliberated by the respondents as follows:

"A [lump sum] contract takes a long time to be justified [to the client], especially about the rate."

"A contract payment that is based on the bill of quantities is more straightforward [than a lump sum-based contract]."

Furthermore, appropriate terms of the contract enabled confidence among the construction project parties. Stage-by-stage payments with clear evidence greatly facilitated the parties to understand and evaluate the progress of the project (Judi et al., 2017). Additionally, changes in contracts or construction plans need to be added and adjusted accordingly. Gokulkarthi and Gowrishankar (2015) emphasised the incorporation of changes in the construction project terms to manage the conflicts arising from project changes.

Enhancement of Financial Management

Lack of financial management practices were highlighted by the respondents. Clients and contractors may tackle payment issues through the appropriate financial management of construction projects. The respondents stated as follows:

"On the developer's [client] side, they have to make sure [to review cash flow] ...that they must have sufficient funding before and during the development."

The contractors emphasised the facts by stating:

"To prevent delays in processing VOs, contractors should be able to identify if there is additional work. Contractors should also provide an accurate work estimate together with sufficient evidence and explanation for the additional work to ensure clients can manage the cash flow consistently."

A realistic cash flow review with the right strategies empowered clients to manage cash appropriately. Adopting interim payment procedures and the right strategies to handle project changes reduced payment delays (Nayan et al., 2017). Cash flow management using the system approach also empowered the clients to manage cash flow and streamline claim payments (Hou et al., 2011).

Improved Payment Procedures

The construction industry needed to facilitate payment processes and procedures. The division of whole projects into smaller payment stages reduced the processes involving payment requests and acquisitions. The respondents confirmed this by saying that:

"Shortened [the] work process [and time is taken for each step] will reduce the time taken in obtaining a payment certificate."

A similar opinion was offered by contractors. The contractors viewed that payment delays were caused by verification processes and physical checking in the construction project. They raised the matters by stating that:

"The client should shorten the process of checking and evaluating the payment claim when there are already too many people involved in checking every payment claim made."

An integral part of the payment process involved acquiring a completion certificate to process or delay payments. A joint checklist empowered the parties involved to reduce the payment process time. The clients addressed the issue as follows:

"I think this issue [delay in certification] can be overcome if and when the contractor has the Standard Operating Procedure (SOP) and checklist [for the payment process] like [client] consultants."

Furthermore, the awareness of procedures on the contractors' part played an integral part in payment delays. The clients forwarded the opinions as follows:

"If contractors truly understand the procedure [the one required by the client], they will be more aware of how important it is to get written verification from the client, in case of abrupt changes in work [VO]. When that happens, the client will be able to proceed with payment claims immediately after all the work is done."

"The consultant and contractor will be present on-site for the briefing session of the project. At this moment, the briefing will be given to everyone involved. We know where our internal processes are not changed, and that is why the contractor should make sure they can adapt to our [client] internal processes."

A similar observation was shared by the respondents on the lack of smooth and workable payment procedures to be streamlined in the construction industry. A reasonable payment timeline must be established for payment disbursements to the contractors (Ansah, 2011). The formation of SOPs for payment also enabled the streamlining of contractors' payment requests to clients (Ali et al., 2015). Hence, confidence-building and realistic expectations between the relevant parties can be developed. The recommendations offered by Gokulkarthi and Gowrishankar (2015) entailed those contractual changes must be duly verified and evaluated by both parties to receive client payments. Consequently, improved contractual and payment procedures benefitted all the parties involved.

External Benchmarking

External learning and the implementation of appropriate practices could help to reduce late payment issues. Thus, external benchmarking enabled the use of efficient industrial practices adopted in the construction industry to solve late payment issues. The respondents reflected on the topic as follows:

"When there is VO, the government would not immediately decide whether to execute or not because they [the clients] will look at the cost first... the cost prepared by the consultant based on the contract rate, agreed-to rate, and daywork rate. The estimated cost is produced and submitted to the government [the client]. The contractor will only proceed to execute the additional work once the government [client] agrees with the estimated cost presented."

The public works department is a good industrial benchmark. For example, the agreed rate enabled the reduction of ambiguity and mitigated cost valuation and payment disbursement issues. The additional work was first decided before execution. Another client added to the argument on adapting payment procedures from governmental projects as follows:

"The VO procedure for government projects is comprehensive and effectively managed. Private organisations can use this as an example or as a reference."

The contractors were also positively inclined towards the use of payment systems. They regard the public works department served as an external benchmark to regulate the payment system in construction by putting forward their views as follows:

"Public Works Department (JKR) has good project management [related to payment]."

Therefore, the use of public works payment system as a benchmark is essential to reduce late payment issues in the construction industry. Similar recommendations were offered by Judi et al. (2017) to learn from external sources or other industries and streamline payment issues in construction.

CONCLUSION

Late and underpayment issues are critical issues of construction industry globally. Viable solutions are necessary for the development and smooth running of the construction industry. The management of late payment and underpayment issues in the Malaysian construction industry which face problems of the late and underpayment issues caused by the lack of trust among clients and contractors as well as the delay in the preparation of payment documents need to be improved. Lack of documentation as progress report or evidence for the construction project also increases the lack of trust and cause the delay in payment. Trust-building among construction clients and contractors have been proven to be vital to address late payment and underpayment issues. The right policies put forward will strengthen the payment documentation process with the competent staffs' due diligence able to manage the payment issues. It has been suggested that payment issues may be managed with the adoption of payment procedures adopted by the public work sectors. Opportunities have been laid down for practitioners and researchers to seize the various strategies in reducing late payment and underpayment issues and streamlining timely project completion in construction which can benefit the industry as well as the overall economic activities generated by the construction industry.

REFERENCES

Abdul Jalil, A., Jaafar, M., Mydin, M. A. O. & Nuruddin, A. R. (2017) How Industry Players Perceived Payment Issues in Industrialized Building System (IBS) housing projects? *Malaysian Construction Research Journal (MCRJ)*, *2*(2): 1 - 22.

Abdul Rahman, H., Ye, K. M. & Wang, C. (2014) Late Payment and Non-Payment Encountered by Contracting Firms in a Fast-Developing Economy. *Journal of Professional Issues. Engineering Education and Practice, 140*(2): 1–9.

Aftab, H. M. (2014) Contractor Perspective on Time Overrun Factors in Malaysian Construction Projects. *International Journal of Science, Environment and Technology*, *3*(3): 1184–1192.

Ali, M. J., Manaf, A. A. W., Choy, C. Y., Hamid, A., M. I. & Mahyut, S. M. (2015) Is There any Accurate Solutions: Late Payment, Under Payment and A Non-Payment Issues in the Construction Industry. *Australian Journal of Basic and Applied Sciences*, *9*(37): 97–103.

Ansah, S. K. (2011) Causes and Effects of Delayed Payments by Clients on Construction Projects in Ghana. *Journal of Construction Project Management and Innovation*, *1*(1): 27–45.

Aryal, A. and Dahal, K. R. (2018) A Review of Causes and Effects of Dispute in the Construction Projects of Nepal. *Journal of Steel Structure & Construction, 4*(2): 1-7.

Bagrecha, K. and Bais, A. (2017) Study on Delay Construction Project in India. *International Journal of Innovations in Engineering Research and Technology [IJIERT]*, *4*(11): 6–10.

Bakhary, N. A., Adnan, H. and Ibrahim, A. (2018) Construction Claim Problems in Malaysia: From the Contractors Perspective. *MATEC Web of Conferences*, *192*(6), 1-4.

Construction Industry Development Board (CIDB) (2017) Construction Quarterly Statistical Bulletin, Kuala Lumpur.

Construction Industry Development Board (CIDB) (2015) Construction Industry Transformation Programme (2016- 2020), Kuala Lumpur.

Creswell, J. W. (2014) Research Design Qualitative, Quantitative and Mixed Methods Approaches (4th edn). SAGE Publications Ltd.41-45 pp.

Cunningham, T. (2018) Preparing Interim Payment Valuations for Construction Works - Worked Examples and Solutions.

Dzulkalnine, N., Azman, M. N. A. & Bing, K. W. (2017) Payment Issues in Malaysian Industrialized Building System (IBS) Industry. *Malaysian Construction Research Journal (MCRJ)*, *2*(2): 1-36.

Enshassi, A., & Abuhamra, L. (2015) Delayed Payment Problems in Public Construction Projects: Subcontractors' Perspectives. *American Society of Civil Engineers*: 567–575.

Gokulkarthi, M., & Gowrishankar, K. (2015) A Study on Impacts of Change Order in Construction Projects. *International Journal of Science and Engineering Research (IJOSER)*, *3*(1): 65–72.

Harmon, K. M. J. (2003) Resolution of Construction Disputes: A Review of Current Methodologies. *Leadership and Management in Engineering*. 187–201.

Harris, F. & McCaffer, R. (2003) *Modern Construction Management* (5th ed). UK: Blackwell Science.

Hou, W., Liu, X. & Chen, D. (2011) Payment Problems, Cash Flow and Profitability of Construction Project: A System Dynamics Model. 693–699.

Hussin, S. N. & Ismail, Z. (2015) Factors to Further Enhance the use of Mediation in the Malaysian Construction Industry. *Journal of Technology Management and Business*, *2*(1): 1-19.

Ishak, M. F., Alauddin, K., Shahrol, M. & Ibrahim, H. (2019) Late and Non-Payments Issues in the Malaysian construction industry: Perspective of Building Material Suppliers. *Malaysian Journal of Sustainable Environment*, *6*(1): 39–56.

Judi, S. S., Mustaffa, N. E. & Nayan, R. (2017) A Framework for Combating Payment-Related Issues (PRI) in the Malaysian Construction Industry. *Journal of Built Environment Technology and Engineering*, *2*(March): 122–132.

Judi, S.S. (2020) Model of Proactive Preventive Solutions for Improving Late Payment and Under-Payment Issues in the Malaysian Construction Industry. PhD Thesis, Universiti Teknologi Malaysia.120-127 pp.

Mazani, Q. A., Sahab, S. S., & Ismail, Z. (2019). Trends of Adjudication Cases in Malaysia. *MATEC Web of Conferences* (Vol. 1, pp. 1–6).

Mohd Badroldin, M. K. A., Abdul Hamid, A. R., Abdul Raman, S., Zakaria, R. and Mohandes, S. R. (2016). Late Payment Practices in the Malaysian Construction Industry. *Malaysian Journal of Civil Engineering 28 Special Issue*, *162*(3), 149–162.

MWED, Online (2019). Merriam-Webster.com. doi: http://www.merriamwebster.com/dictionary.

Nayan, R., Mustaffa, E. & Judi, S. S. (2017) Valuation of Interim Payment: Issues Encountered by the Parties Involved in relation to Interim Payment. *Built Environment, Technology and Engineering, 2*: 133–141.

Nyoni, T. & Bonga, W. (2017) Towards Factors Affecting Delays in Construction Projects: A Case of Zimbabwe. *Journal of Economics and Finance*, *2*(1): 12–28.

Omran, A. & Suleiman, A. S. H. (2017) Identifying the Competence Components of the Construction Project Managers in the Palestinian Construction Industry. *The Engineering Project Organization Journal*, *7*(2): 1-26.

Saunders, M., Lewis, P., and Thornhill, A. (2012) *Research Methods for Business Students*, (6th ed.) Financial Times/Prentice Hall, Harlow.

Shah, R. K. (2016) An Exploration of Causes for Delay and Cost Overrun in Construction Projects: A Case Study of Australia, Malaysia & Ghana. *Journal of Advanced College of Engineering and Management*, *2*: 41–55.

Soni, S., Pandey, M. & Agrawal, S. (2017) Conflicts and Disputes in Construction Projects: An Overview. *International Journal of Engineering Research and Applications*, *7*(6): 40–42.

Xie, H., Zheng, J., Zhang, Y., & Li, H. (2019) Effects of payment at two links in payment chains on the progress of construction projects: System dynamic modelling and simulation. Sustainability, 11: 1-25.

FROM MODELLING TO MANAGEMENT OF PROJECT DELIVERY: REVIEW ON CLASH MANAGEMENT PROCESS WITH BIM IN MALAYSIA

Mustafa Fawaz[1], Rahinah Ibrahim[1*], Ali Rashidi[2] and Maszura Abdul Ghafar[1]
[1]Faculty of Design and Architecture, Universiti Putra Malaysia, UPM Serdang, 43400, Selangor, Malaysia.*
[2]School of Engineering, Monash University Malaysia, Bandar Sunway, 47500, Selangor Darul Ehsan, Malaysia.

Abstract
CITP 2016-2020 (Construction Industry Transformation Program) targets higher rate of implementation for Building Information Modelling (BIM). The Industrial Revolution (IR) 4.0 Roadmap for Construction Industry 2020-2025 further emphasizes the utilization of Building Information Modelling (BIM) and Industrialized Building Systems (IBS) to increase productivity in the Malaysian construction industry. One benefit of BIM is enhancing interactions between different team members and reducing the clashes since the design phase of an industrialized project. Despite all the efforts to avoid the construction clashes during design stage with the use of BIM models, there has been no ideal construction process with nil clashes. Hence, our study aims to identify the key areas where BIM could support the clash management process during a project's lifecycle. The paper discusses about the clash management process, the barriers and challenges for BIM implementation, and the use of BIM technology for developing countries surrounding the BIM technology's process, organizational stakeholders, and the BIM product. In reference to Malaysia, results include the extant of BIM impacts on the construction industry due to its restrictions during the design stage of the project. Results found alignment of BIM products to the management team's actions during clash management process has potential to support BIM implementation and improve construction productivity, and thereby, reducing future reworks. Further studies are recommended to focus on automation in BIM technology during the construction stage specifically for improving in-situ clash management. This paper contributes to improving construction productivity and professionalism with BIM and industrialized building products to support IR 4.0 Roadmap for Construction Industry 2020-2025 in Malaysia.

Keyword: *Building Information Modelling (BIM); clash management; Design-Construction Informatics; Built Environment Informatics; IR 4.0.*

INTRODUCTION

The construction industry is a key economic engine for Malaysia's overall economy. According to the Construction Industry Development Board (CIDB) 2015 the construction industry has been contributing 4 percent to its Gross Domestic Product (GDP) and was expected to contribute 5.5 percent to the Malaysian GDP by 2020. The construction industry practice seeks for improvement over time by adapting new technologies and approaches. In pursuing this goal, the last decade saw the construction industry introducing Building Information Modelling (BIM) among industry professionals. According to CIDB (2015) the adoption of BIM technology in Malaysia is still low at 10 percent, in contrast to the United States at 71 percent, Singapore at 65 percent, and the United Kingdom at 39 percent. The adoption of BIM in Malaysia faces several challenges including lack of guidelines, lack of skill and high cost of adoption. Furthermore, challenges during construction stage include difficulty in collaboration between disciplines, and slow adaptation on current work practices for implementing the technology seamlessly. BIM has become the new invention to fulfil the needs of an industry and improves its work performances by presenting a collaborative environment through integrated design decisions by multiple team members such as contractors, architects, engineers and consultants.

Different opinions tend to arise during project construction, which would cause multiple changes during the design process, yet they are necessary in order to avoid rework thus preventing the wastage of the resources (Seo et al., 2012). This different opinions combined with different background or experience of project's participants calls for better management and coordination for the collaboration process and their data exchanges between these stakeholders during implementation (Barison and Santos, 2010). Moreover, previous studies in the Malaysian context have shown the importance of the clash management on the improvement of construction industry in developing countries. They also investigated the impact of the construction clashes and the variation orders on the construction industry as well as the significant increase of the clashes in building project using the conventional methods of construction (Mohammad, 2010; Hameed Memon, Abdul Rahman and Faris Abul Hasan, 2014).

METHODOLOGY

With the intent to understand the aspects effecting implementation of the BIM technology to Malaysia, the authors conducted a literature review on selected topics surrounding BIM support for clash management during a project's lifecycle. Keywords were identified using Ibrahim's (2011) research question's construct (or RQ Construct) categorization technique for identifying three different RQ Constructs—"WHO", "WHAT" and "HOW"—in formulating a main research question. Ibrahim defines "WHO" construct as the element used or impacted by a research, "WHAT" construct as the information required to solve a research problem, and "HOW" construct as the action or impact on the element or information of the research. In this study, the authors analysed BIM in view of its *process, organization,* and *product,* and develop relations on clash management process during on-site construction. For each topic, this paper will present the major works by prior scholars, how their works could support future studies, and what aspects need to be enhanced for each selected topic. This exercise produces a synthesized summary for each topic. Then, the paper will further cross-analyse the synthesized summaries, integrate potential possibilities, and prioritize them towards high probable solutions that could improve the clash management process using BIM. This paper concludes with a discussion on potential integrated solutions for future development of a theoretical framework for supporting construction productivity with BIM. The aim is classifying the impacts of BIM on the clash management process before recommending future mitigation strategy for the construction industry in Malaysia.

BUILDING INFORMATION MODELLING (BIM)

The term BIM can refer to Building Information Modelling, or Building Information Management (Czmoch & Pękala, 2014). Some researchers define BIM as a process used to simulate a construction project in a multi-dimensional digital model and provides multitudes of project benefits (Azhar, Khalfan, and Maqsood, 2015). Others define BIM as a set of technology developments and processes that has transformed the way infrastructure is designed, analysed, constructed and managed (Succar, 2009; Davies and Harty, 2013). The American Committee of the National Information Model Standard Project Committee (2013) defines BIM as "a digital representation of physical and functional characteristics of a facility and a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition". U.S. Government General Services Administration defines BIM as "the development and use of a multi-faceted computer software data model to not only document a building design, but to simulate the construction and operation of a new capital facility or a recapitalized (modernized) facility" (Czmoch & Pękala, 2014).

The status of BIM implementation is shown in four levels. These levels reflect the maturity of BIM implementation in any country, and currently the maturity of BIM in Malaysia is still at Level 1. BIM Level 0, is defined as unmanaged CAD. This is likely to be 2D CAD, with information being shared by traditional paper drawings, essentially separate sources of information covering basic asset information. Majority stakeholders in the industry are already well ahead of this now. BIM Level 1 is the level typically comprises of a mixture of 3D CAD for concept work, and 2D CAD for drafting statutory approval documentation and production information. BIM Level 2 is distinguished by collaborative working where all parties use their own 3D models and not working on a single shared model (CIDB, 2015). Collaboration at Level 2 comes in the form of how the information is exchanged between different parties. BIM Level 3 is also called iBIM or Intelligent BIM where full collaboration does happen between all disciplines by means of a single, shared project model held in one large database (e.g., BIM cloud). Through this model, all parties can access and modify that same model (Sacks, Eastman, Lee, & Teicholz, 2018).

This study agrees on the use of BIM at construction projects would make it an efficient enabler for better team engagement. To ensure the successful participation of a team, a BIM-enabled project requires its plans to be created to meet certain established expectations and resolve the project's details at earlier design phase. Hence, according to Fountain and Langar (2018), clash detection becomes the most critically outsourced service when using BIM. In the succeeding sections, this study will present how BIM could accommodate many of the functions needed to model the lifecycle of a building. It will describe how BIM improves new construction capabilities, and how it changes the roles and relationships of a project team from three main aspects: Process, Organization, Product.

BIM (The Process)

BIM is a virtual process that involves all the systems and disciplines of the facility allowing the project team to collaborate more accurately and efficiently than traditional processes. As the model is being created, team members are continuously adjusting their portions according to project specifications and design changes to ensure the accuracy of the model before proceeding to the construction phase. BIM implementation has been of interest to many researchers. Among them include discussing current status (Howard and Björk, 2008), implementation impacts and the critical conditions (Chi et al., 2014), and the willingness of the industry to widely using it (Gu and London, 2010). The implementation of BIM differs from one country to another where investigation on approaches in several countries would demonstrate the most effective implementation in the construction industry (Smith, 2014b). Moreover, researchers usually ended up using qualitative method to capture insights into the process of BIM where many used case studies for discussing concept development (Migilinskas et al., 2013), generalizing the collaboration (Bråthen, 2015), and integrating BIM and lifecycle assessment (Soust-Verdaguer et al., 2017). Hereby, BIM could offer a potential digital solution space for design errors and clashes occurring during design (Seo et al., 2012). Therefore, this study agrees that more studies are needed to mitigate clashes during the early project lifecycle process in order to arrest clashes later in the implementation stage.

Furthermore, a number of researchers also focused on studying the benefit, problems, obstacles of the implementation reaching the best practice, feasibility of BIM (Howard and Björk, 2008; Lindblad and Vass, 2015; Migilinskas et al., 2013; and Smith, 2014b). As well as interactive visualization, systematic modelling, and standardize data exchanging (Chi et al., 2014). Others focused on enhancing performance for building design by reducing data acquisition (Soust-Verdaguer et al., 2017). Gu and London (2010) initiate a BIM decision framework to collaboratively facilitate BIM adoption in the industry. Seo et al. (2012) identifies the clash detection tasks at the design phase and analyse its current process, while Bråthen (2015) investigates the effect on collaboration and work practices through the use of BIM in real-life projects to answer these issues. Reviewing these studies leads to a conclusion that a BIM process has been facing numerous barriers and researchers are continuously trying to improve its effectiveness and efficient implementation.

Despite the advantages of BIM, the same authors showed that BIM could improve further. These studies have focused on BIM as a process from different perspectives and from different countries. This highlighted a necessity to review the BIM process in Malaysia through its local lens as per recommended by (Smith, 2014b; and Howard and Björk, 2008). Many scholars used literature review to discuss the use of BIM as a process (Chi et al., 2014; Gu and London, 2010; Seo et al., 2012; and Soust-Verdaguer et al., 2017). Despite the efforts, these results need to be tested on the ground and qualitative methodology is recommended to provide deeper information and better understanding especially on the design decision-making across the project team. One study by Migilinskas is conducted on design error reduction, and it is also limited to the design team (Migilinskas et al., 2013). Hence, more studies are called for from data in later stages so the industry could reduce design errors earlier.

In order to improve the implementation of BIM there is a need to understand and document the current stats in the AEC industry as several researchers have pointed out (Howard and Björk, 2008; Gu & London, 2010; and P. Smith, 2014b). Apart from Chi et al. (2014); Migilinskas et al. (2013); Seo et al. (2012); and Soust-Verdaguer et al. (2017), this study would like to discuss the impact of BIM in considering clashes at the construction stage when it is utilized on an actual site. Furthermore, this study recommends exploring how to improve the decision-making process and capturing the clashes occurring during construction and cannot be detected during the design stage. Finally, with BIM as a process limited to the design phase, further focus is recommended on enhancing BIM usage during the construction stage. This enhancement is expected to support the construction management team to resolve unforeseen clashes that appear during construction.

BIM (The Organization)

The study finds adoption of BIM has changed the work practice and the team skills in the industry's organizations. The implementation of BIM has been depending upon performing changes to an organization to make fully use of its technological benefits (Lindblad and Vass, 2015). Succar (2009) presented a framework to describe the changes on the organizational framework he described for BIM implementation as a progressive development of interacting policies, processes and technologies influencing different actors and organizations. Furthermore, the scholar opined that the higher the maturity of adoption, the higher will the change be to the organization. Hence, this study agrees that in order to understand BIM impacts better, researchers need to understand the organizational aspects as well, especially on how human factor would affect the impact of BIM on the management process.

The organization aspect mainly focuses on the BIM team. Among them include the need to define the responsibilities for the team (Azhar, 2011) and its competency mapping (Murphy, 2014). Barison and Santos (2010) tried to understand these responsibilities and distinguished several specialties. Furthermore, it is necessary to discuss the BIM job and the required skills for each of the BIM jobs (Uhm, Lee, and Jeon, 2017) with potential demand for new roles in future teams operating BIM (Ghaffarianhoseini et al., 2016). There are possibilities that these roles may affect the clash management process due to the individuals' attitude and the actions by team members in respect of their responsibilities. One role has the title as BIM manager who would have earned it through his or her increase demonstration of certain BIM skills (Rahman et al., 2016). Ghafar et al. (2014) also discussed the culture and the human factor which would affect the use of BIM technologies in industrialized building projects. Additionally, Bryde et al. (2013) and Gathercole and Thurairajah (2014) discussed the reality of BIM and reviewed the benefits and challenges to the stakeholders to adapt such a technology. A study by Smith (2014a) had examined BIM in the construction industry from the professional's aspect while Lindblad and Vass (2015) explored how a large public client implements BIM in their organization.

Reviewed studies had focused on understanding the effect of BIM on their organizations. Uhm et al. (2017) and Murphy (2014) identified BIM jobs with their related competencies and duties. Barison and Santos (2010) identified the individual responsibilities of the BIM Specialists and their respective areas and functions. Ghafar et al. (2014) supported the BIM technology implementation regarding communication culture, effective cultural knowledge to mitigate knowledge loss. Gathercole and Thurairajah (2014) determined a set of management, coordinating and roles that interacted with BIM. Azhar (2011); Ghaffarianhoseini et al. (2016); and Smith (2014a) discussed the benefits and the issues with BIM implementation and its potentials and challenges. Bryde et al. (2013) collected data from multiple projects that have applied BIM to document the most benefits from the use of BIM. Rahman et al. (2016) focused on designing better BIM education programs for college and the learning programs.

In view of the above studies, this study found most organization-related studies had focused on team competency and its responsibilities. Hence, this study supports Barison (2010) and Murphy (2014) on further studies in formalizing the competency requirements based on the organizational approach. Studies of Gathercole and Thurairajah (2014), Rahman et al. (2016), and Uhm et al. (2017) used online survey, and social network survey, to obtain clearer scope of required competencies such as; "engineering and technology knowledge, technical vocational education, work activity of establishing and maintaining interpersonal relationships, and BIM-related work experience". This study agrees that a real site observation can provide better accuracy and deeper information on understanding the effects of team competency regarding clashes. Therefore, it is not surprising to note a need for more awareness regarding upskilling of staff in construction firms (Holzer, 2012; and Bryde, 2013). This study noticed differing challenges from one country to another and calls for appropriate contextualization towards BIM implementation for each country in view of the local team adoption challenges (Azhar, 2011; Ghafar et al., 2014; Ghaffarianhoseini et al., 2016; and Smith, 2014a).

From the organizational aspect, it seems BIM is yet to become a panacea for the AEC industry since there exist a large number of challenges and issues surrounding any successful implementation. Moreover, there is no clear guidance for team's roles and their minimum required competencies since organizations tend to follow the operational culture in the respective country where they operate (Barison and Santos, 2010; Bryde et al., 2013; Ghafar et al., 2014; Murphy, 2014; and Uhm et al., 2017). In the case of Malaysia, the adoption of this technology would require additional observance of current state of management and the local operating culture. Apart from Holzer (2012); Smith (2014a); Gathercole and Thurairajah (2014); Ghaffarianhoseini et al. (2016); and Rahman et al. (2016), more documented information is recommended through observational data at a real site to ensure capture of the team's opinions and members' suggestions in improving the technology's adoption. As a result, this study posits that understanding and aligning the management actions for BIM implementation with the organization's operational culture could expedite the organizations' readiness to adapt to new procedural methods.

BIM (The Product)

The application of new technology such as BIM has the tendency to face multiple challenges and risks while a project's team implements the technology. Many researchers have highlighted the benefits and challenges (Azhar, 2011), or discussed about the challenges specifically for remote construction project (Arayici, Egbu, and Coates, 2012). Eadie et al. (2013) and Azhar et al. (2015) both discussed the technological impacts on people of BIM usage throughout the project's lifecycle. Wang et al. (2013) discuss the integration of BIM with augmented reality. On the other hand, Chien et al. (2014) identifies the risk factors that related to the technical, management, financial, personnel, and legal aspects of BIM. While Zhao, Feng, Pienaar, and O'Brien (2017) identifies the risks associated with BIM implementation in the AEC projects. The scholars were able to model the paths of these risks creating hypothetical risk paths were tested using partial least square-structural equation modelling.

Azhar (2011) provides the needed information regarding the integration of the roles of all stakeholders on a project for AEC industry considering implementing BIM technology in their projects. Arayici et al. (2012) shows how BIM adoption would do for an architectural company in mitigating management problems, while Eadie et al. (2013) measures the use of BIM in different project stages. Wang et al. (2013) proposes a conceptual framework that visualized the physical context of each construction activity while integrating BIM with augmented reality. Azhar et al. (2015) aims to illustrate the risks and challenges of the implementation and future trends described into two categories technical and managerial. Mehran (2016) conducted a questionnaire survey to academics and construction professionals working on BIM projects to discuss the adoption of BIM in developing countries such as UAE. The research result reveals three critical barriers in BIM implementation: lack of BIM standards, lack of BIM awareness and resistance to change. Zhao et al. (2017) study eight risk paths that were statistically significant, such as technological issues, collaboration, information sharing, and data security issues.

The above-mentioned studies demonstrated the impacts of BIM are often limited to design stage in developing countries. These findings enforce our agreement with Mehran (2016) on the need to understand current adoption of BIM according to the country of operation. In enabling the application of BIM, Azhar (2011); Arayici et al. (2012); Eadie et al. (2013); and Azhar et al. (2015) discussed facilitating this technology for on-site application and fulfil the management team's needs. Earlier methodology by Chien et al. (2014) and Zhao et al. (2017) are based on results of quantitative approach while this study would like to suggest qualitative approach to enhance situational understanding of real human needs in adapting the technology and making use of expert's opinion.

According to Arayici et al. (2012); Azhar (2011); and Azhar et al. (2015) there is a need for aligning the technology to fulfil the management team's needs. Chien et al. (2014) and Eadie et al. (2013) had recommended to investigate the impact of BIM throughout the construction stage within professionals' aspect. In summarizing BIM as a product, automating the clash management process is supported as it would extend the BIM function into construction stage by coordinating organizational strategy with delivery expediency.

CLASH MANAGEMENT WITH BIM

Building Information Model (BIM) supports owners, designers, and contractors in coordinating building design systems, planning of construction work, processing of fabrication, and maintaining the facility. Traditionally, clashes have been identified manually when overlaid sheets of drawing on a light table would put heavy reliance on the project manager to carry out the visual clash detections (Eastman et al., 2008). Such approach has changed with the introduction of BIM. A BIM model is a combination of multiple models, where each model is independent from the other and each model refers to a specific discipline (such as architecture, structural engineering, MEP engineering, environmental engineering, etc.). Upon the combination of these models into one integrated model, clash detection becomes a simpler operational process to find where the models clash such as capturing incompatible object, layer interference or occupying the same place (Bhagwat and Shinde, 2016). Although this procedure could capture any clash, they are still limited to the information given by the 3D models involved. Often, differences in measurements from real site and the site conditions may cause changes in the project that would differ from the perfect 3D model. In lieu of this situation, Pärn et al. (2018) refer to clashes as positioning errors where building components overlap each other. Despite BIM having the ability to easily detect MEP and architectural design clashes in the design phase, the MEP and structural could still occur in the latter phase (Ciribini et al., 2016).

Many researchers had tried to define and classify the clashes during the different stages of the project's lifecycle. Lopez et al. (2010) focused on design errors in construction in order to classify these clashes leading to their causes and recommended respective preventive actions. Additionally, Jeffrey Boon Hui Yap et al. (2018) focused on the design stage in discussing the systematic effects on the design changes while Seo et al. (2012) investigated and corrected clash detections during the design phase. Others had concentrated on specific types of clashes, such as Pärn et al. (2018) had focused on the clash detection between MEP and structural systems. Tommelein and Gholami (2012) focused on the root causes of clashes in BIM that include design uncertainty and failing of design rules. Since BIM is considered the platform for multiple tools to detect clashes, researchers tend to focus on selected tools, e.g., Autodesk Revit (Bhagwat and Shinde, 2016). Other researchers focus on clash management as Love, Lopez, and Kim (2014) who studied design error management that classified errors as *people*, *organization*, or *project* caused. Evaluating BIM impacts has been the main interest for many researchers such as Bockstael and Issa (2016) who propose the application of failure mode and effects analysis as a methodology to conduct clash detection and evaluating the impacts of using BIM software on constructability. Won and Lee (2016) evaluated the successful level of BIM by evaluating the BIM projects using success level assessment model. Tulenheimo (2015) analysed obstacles generated by customers, company's own organization, social behaviour, and immature technologies as clash sources. In an effort to reduce construction clashes, Ciribini et al. (2016) optimized the construction process, and proposes the implementation of BIM-based validation and construction optimization.

This study agrees that in order to understand clash management, there is a need to understand BIM impacts and how to measure them as per recommended by Pärn et al. (2018) and in addition, how could these impacts prevent future failures (Bockstael and Issa, 2016). On this regard, researchers have proposed several methodologies for assessment and classifying the impacts according to people, organization, and product (Lopez et al., 2010). In addition, another study identifies hindrances in clash detection tasks and analyse its current process (Seo et al., 2012). Peansupap and Ly (2015) used Likert scale to evaluate design errors in structural mechanical and structural plumbing. Bhagwat and Shinde (2016) evaluates the advantages of selected new technology on the basis of modelling and clash detection. Love et al. (2014) produced a systemic framework for the design error management to reduce errors to arise in construction. Jeffrey Boon Hui Yap et al. (2018) discussed the causal nature of design changes and its dynamic impacts on project performance. Ciribini et al. (2016) performed a semi-automatic validation process for the architecture, structure and MEP models also an auto-matching between BIM objects and the construction activity. Won and Lee (2016) used two projects to collect and analyse data related to schedule, design errors, change orders, response time.

The above the reviewed studies focused on classifying these clashes by discussing areas such as; *types of clashes* (Peansupap and Ly, 2015; Won and Lee, 2016), *density* (number of clashes) (Bockstael and Issa, 2016; Pärn et al., 2018), *the root cause* (Tommelein and Gholami, 2012) and *clashes reduction* (Love et al., 2014). However, most these studies focus on clashes that occur during the design phase, while there is obvious lacking on the clashes occurring during on-site construction which passed the design clash coordination. The on-site clashes affect the construction process and waste enormous time and money due to reworking. Furthermore, there is a dearth of studies for a real site case study in order to gain more deep information regarding the clash management (Lopez et al., 2010; Love et al., 2014; and Seo et al., 2012). Such case study would provide valuable insights to the operability of available tools for achieving clash detection process (Bhagwat and Shinde, 2016), obtaining feedbacks on challenges due to BIM implementation while offering better management of clashes during the construction stage (Tulenheimo, 2015 and Ciribini, 2016).

DISCUSSIONS

The above sections have described BIM from three main themes: *Process, Organization*, and *Product*. Now, this study would like to discuss how BIM could play role in clash management and recommends how BIM could better support in clash management. This study found the most powerful feature of BIM is its ability to visualise clash detection. Figure 1 illustrates how the three themes could converge for BIM implementation. As a process, BIM is most efficient during the design phase and has opportunity to be extended into the construction phase. As an organizational support, BIM requires understanding of management's actions that is often culture-based during construction operation. As a product, BIM has limitation in its offering as a comprehensive tool when on-site managers are using traditional means to resolve clash management incidents. In lieu of the three perspectives, this study is recommending the BIM process and product to support the construction management team during clash management. This study also recommends further understanding of contextual culture-based conflict resolutions to support management's actions. In view of the above, the findings open an opportunity for automating clash management and resolution process to improve productivity in construction projects.

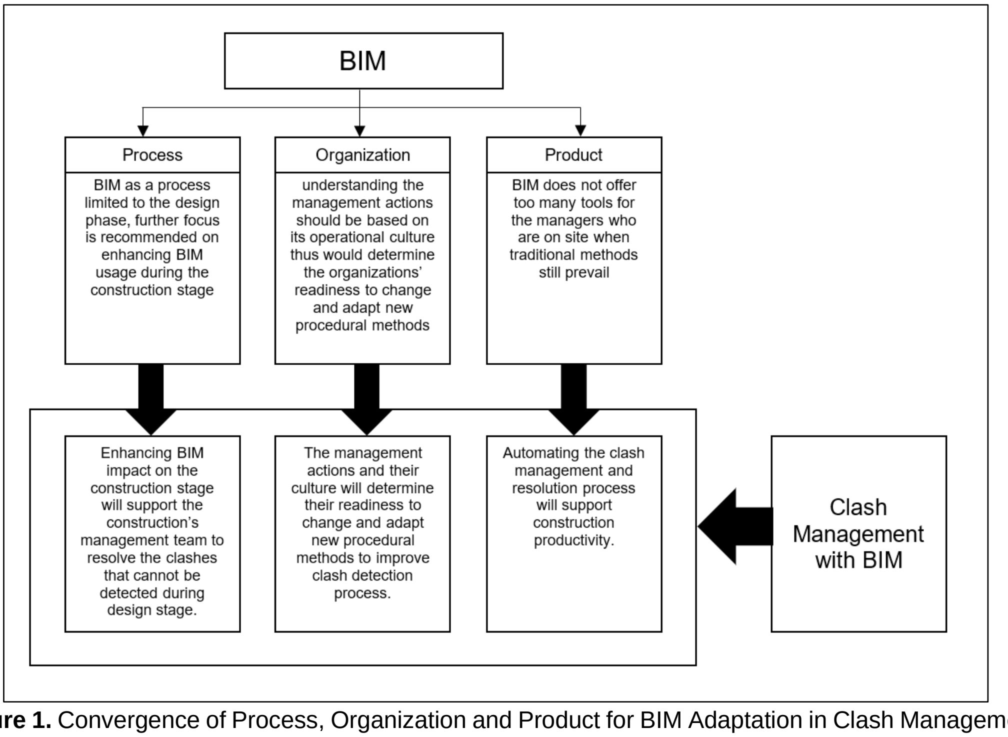


Figure 1. Convergence of Process, Organization and Product for BIM Adaptation in Clash Management

Taking Figure 1 further, this section now discusses the critical factor in converging the process, organization and product for BIM application in clash management process. This study notes the emergence of *management actions* that is necessary to support and implement *automation in construction* since despite the use of BIM by building professionals, procedures will fall back onto conventional practice when those handling the conventional procedures are not familiar with BIM workings. For this model to be successful, there is a need to understand the current management actions. Herewith, this study recommends documentation of current management actions taken during different stages of the clash lifecycle such as from detection until solving the clashes. Additionally, this study highlighted the importance of understanding different team members' roles and actions as they participate in this process. The above behavioural actions are expected to align current process with relevant BIM supportive features, whereby, those behavioural actions are best to support the local cultural behaviour and building practice if any optimization is intended to benefit the local organization.

In *aligning product to actions*, this study agrees with Roslan et al. (2019) regarding the iterative relation between organization, process and product, and the importance of organization for efficient BIM implementation. Therefore, this study posits aligning BIM product with the management team actions would improve efficient BIM impact in supporting the construction productivity. From the above dyad analysis where the study had cross-analysed one theme with another (such as process and organization; organization and technology; and technology and process) the authors found the existence of a tri-party iterative relationship between product, organization, and process of BIM in order to construct a comprehensive model that would align BIM to clash management process. Hence, this study posits that incremental alignment of BIM product to the management team's actions during clash management process can support BIM implementation and improve construction productivity. The proposed Model for Management Alignment for BIM for Automation in Clash Management Process is illustrated in Figure 2 below.

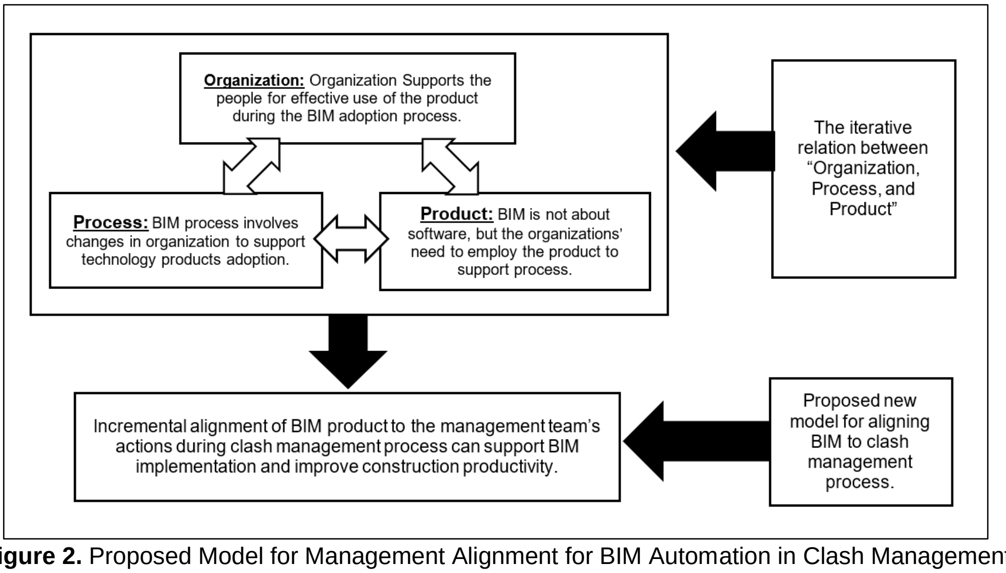


Figure 2. Proposed Model for Management Alignment for BIM Automation in Clash Management Process

The proposed Model establishes earlier supports for management of discontinuous organization by Ibrahim & Paulson (2008) through detection process, the reporting system and the decision-making in managing clashes. Even though BIM encourages "sterile" in-office approach to project delivery during its design stage, this study foresees that building professionals would still require diligent awareness on the four environmental factors (ibid.) in dynamic construction project delivery, which may be brought about by non-obvious causes, such as unpredictable site conditions or unreliable lower manpower skills. Moreover, this study found current situation seems to relegate BIM tools as mere tools for final documentation of projects that would document adjustments to scheduling due to reasons such as weather, cost variances, or technical support availability. The authors found opportunities in extending the usability of BIM tools to include ways and means of project management's actions and the organization's operational culture (as per recommended by Ghafar et al., 2014) that enriches a "technical" BIM product to include "human factor" in mitigating unpredictable implementation delivery. In lieu of integrating human factors into technology development or expansion of use, this study recommends the use of qualitative approach research methodologies to capture and understand the intangible intents in human responses such as in this case, for improving clash management reactions by project stakeholders. In time, BIM utility in Malaysia would mature from modelling of project to management of project delivery. Such advancement could follow Ibrahim & Kweku's (2018) demonstration how an advanced management tool had helped streamline manmade complexities in planning approval process. Perhaps, such precedent could similarly shed light how BIM could be used to integrate and align project management culture for shortening a project's lifecycle delivery.

CONCLUSION

In conclusion, this paper finds BIM as a potential solution for the clash detection process during construction stage. The results include proposing a Model for Management Alignment for BIM Automation in Clash Management Process where appropriate optimization in supporting BIM implementation and improve construction productivity could be developed through incremental alignment of BIM product to the management team's actions. Moreover, it highlights aligning BIM products to the management team's actions and its operational culture for more efficient delivery during the construction stage. Further studies are recommended to focus on automation in BIM technology during the construction stage specifically for improving in-situ clash management. This paper contributes to improving construction productivity and professionalism with BIM and industrialized building products to support IR 4.0 Roadmap for Construction Industry 2020-2025 in Malaysia.

ACKNOWLEDGEMENT

This paper is part of the first author's Master thesis in Architectural Studies at Universiti Putra Malaysia.

REFERENCES

Arayici, Y., Egbu, C., & Coates, P. (2012). Building information modelling (Bim) implementation and remote construction projects: Issues, challenges, and critiques. *Electronic Journal of Information Technology in Construction*, *17*(May), 75–92.

Azhar, S. (2011). Building Information Modeling (BIM): Trends, Benefits, Risks, and Challenges for the AEC Industry. *Leadership and Management in Engineering*, *11*(3), 241–252.

Azhar, S., Khalfan, M., & Maqsood, T. (2015). Building information modelling (BIM): now and beyond. *Construction Economics and Building*, *12*(4), 15–28.

Barison, M. B., & Santos, E. T. (2010). An overview of BIM specialists. *Proceedings of the International Conference on Computing in Civil and Building Engineering Icccbe2010*, (August), 141.

Bhagwat, P., & Shinde, R. (2016). *Clash Detection -A New Tool in Project Management*. *4*(4), 193–197.

Bockstael, D., & Issa, M. H. (2016). A methodology for contractor clash detection using building information modelling on commercial construction projects. *Journal of Information Technology in Construction*, *21*(July 2015), 233–249.

Bråthen, K. (2015). Collaboration with BIM - Learning from the Front Runners in the Norwegian Industry. *Procedia Economics and Finance*, *21*(2212), 439–445.

Bryde, D., Broquetas, M., & Volm, J. M. (2013). The project benefits of building information modelling (BIM). *International Journal of Project Management*, *31*(7), 971–980.

Chi, H. L., Wang, X., & Jiao, Y. (2014). BIM-Enabled Structural Design: Impacts and Future Developments in Structural Modelling, Analysis and Optimisation Processes. *Archives of Computational Methods in Engineering*, *22*(1), 135–151.

Chien, K. F., Wu, Z. H., & Huang, S. C. (2014). Identifying and assessing critical risk factors for BIM projects: Empirical study. *Automation in Construction*, *45*, 1–15.

CIDB. (2015). CONSTRUCTION INDUSTRY TRANSFORMATION PROGRAMME 2016-2020: Driving Construction Excellent Together.

Ciribini, A. L. C., Mastrolembo Ventura, S., & Paneroni, M. (2016). Implementation of an interoperable process to optimise design and construction phases of a residential building: A BIM Pilot Project. *Automation in Construction*, *71*, 62–73.

Czmoch, I., & Pękala, A. (2014). Traditional design versus BIM based design. *Procedia Engineering*, *91*(TFoCE), 210–215.

Davies, R., & Harty, C. (2013). Implementing "site BIM": A case study of ICT innovation on a large hospital project. *Automation in Construction*, *30*, 15–24.

Eadie, R., Browne, M., Odeyinka, H., McKeown, C., & McNiff, S. (2013). BIM implementation throughout the UK construction project lifecycle: An analysis. *Automation in Construction*, *36*, 145–151.

Eastman, C., Liston, K., Sacks, R., & Liston, K. (2008). BIM Handbook Paul Teicholz Rafael Sacks.

Fountain, J., & Langar, S. (2018). Building Information Modeling (BIM) outsourcing among general contractors. *Automation in Construction*, *95*(June), 107–117.

Ghafar, M. A., Ibrahim, R. & Shari, Z. (2014). Embedding Culture Knowledge in Building Information Modeling (BIM) for Fabrication Efficiency to Reduce Industrialized Construction Waste. *Computing In Civil and Building Engineering, 195-202.*

Gathercole, M., & Thurairajah, N. (2014). The influence of BIM on the responsibilities and skills of a project delivery team. *International Conference on Construction in a Changing World*. Retrieved from

Ghaffarianhoseini, A., Tookey, J., Ghaffarianhoseini, A., Naismith, N., Azhar, S., Efimova, O., & Raahemifar, K. (2016). Building Information Modelling (BIM) uptake: Clear benefits, understanding its implementation, risks and challenges. *Renewable and Sustainable Energy Reviews,* (October 2015).

Gu, N., & London, K. (2010). Understanding and facilitating BIM adoption in the AEC industry. *Automation in Construction*, *19*(8), 988–999.

Hameed Memon, A., Abdul Rahman, I., & Faris Abul Hasan, M. (2014). Significant Causes and Effects of Variation Orders in Construction Projects. Research Journal of Applied Sciences, Engineering and Technology, 7(21), 4494–4502.

Holzer, D. (2012). BIM ' s Seven Deadly Sins. *International Journal of Architectural Computing*, *09*(04), 463–480.

Howard, R., & Björk, B. C. (2008). Building information modelling - Experts' views on standardisation and industry deployment. *Advanced Engineering Informatics*, *22*(2), 271–280.

Ibrahim, R, Kweku, H. (2018). Streamlining the Planning Approval Process for a Sustainable Urban Development - A Case Study for Unwinding Manmade Complexities. *Stud. Archit. Urban. Environ. Sci. J.*, 1 (1): 1:10. DOI: 10.x/saues.2018.01.1001.

Ibrahim, R. (2011). Demystifying the Arduous Doctoral Journey with an Eagle Vision of a Research Proposal. *The Electronic Journal of Business Research Methods*, 9(2), 130-140.

Ibrahim, R, Paulson B.C. (2008). Discontinuity in Organisations: Identifying Business Environments Affecting Efficiency of Knowledge Flows in Product Lifecycle Management. *International Journal of Product Lifecyle Management*, 3 (1): 21-36.

Jeffrey Boon Hui Yap, Hamzah Abdul-Rahman & Chen Wang. (2018). Managing Design Change Dynamics In Building Construction: Conceptualizing A Qualitative Model. *Malaysian Construction Research Journal (MCRJ)*. *Special Issue 5* (3).1-13.

Lindblad, H., & Vass, S. (2015). BIM Implementation and Organisational Change: A Case Study of a Large Swedish Public Client. *Procedia Economics and Finance*, *21*(15), 178–184. https://doi.org/10.1016/S2212-5671(15)00165-3.

Lopez, R., Love, P. E. D., Edwards, D. J., & Davis, P. R. (2010). Design Error Classification, Causation, and Prevention in Construction Engineering. *Journal of Performance of Constructed Facilities*, *24*(4), 399–408.

Love, P. E. D., Lopez, R., & Kim, J. T. (2014). Design error management: interaction of people, organisation and the project environment in construction. *Structure and Infrastructure Engineering*, *10*(6), 811–820.

Mehran, D. (2016). Exploring the Adoption of BIM in the UAE Construction Industry for AEC Firms. *Procedia Engineering*, *145*, 1110–1118.

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

Mohammad, N. (2010). Investigation on the Causes of Variation Orders in the Construction of Building Project – a Study in the State of Selangor, Malaysia. Journal of Building Performance, 1(1), 73–82.

Murphy, M. E. (2014). Implementing innovation : a stakeholder competency-based approach for BIM. *Construction Innovation*, *14*(4), 433–452.

Pärn, E. A., Edwards, D. J., & Sing, M. C. P. (2018). Origins and probabilities of MEP and structural design clashes within a federated BIM model. *Automation in Construction*, *85*(September 2017), 209–219.

Rahman, R. A., Alsafouri, S., Tang, P., & Ayer, S. K. (2016). Comparing Building Information Modeling Skills of Project Managers and BIM Managers Based on Social Media Analysis. *Procedia Engineering*, *145*, 812–819.

Roslan, Ahmad Farhan & Hamid, Zuhairi & Zura, Maria & Zain, Mohd & Kilau, Nurulhuda & Dzulkalnine, Natasha & Hussain, Afifuddin Husairi. (2019). Building Information Modelling (BIM) Stage 2 Implementation Strategy for the Construction Industry in Malaysia. *Malaysian Construction Research Journal. 6. 165-173.*

Sacks, R., Eastman, C., Lee, G., & Teicholz, P. (2018). *A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers*.

Seo, J.-H., Lee, B.-R., Kim, J.-H., & Kim, J.-J. (2012). Collaborative Process to Facilitate BIM-based Clash Detection Tasks for Enhancing Constructability. *Journal of the Korea Institute of Building Construction*, *12*(3), 299–314.

Smith, P. (2014a). BIM & the 5D Project Cost Manager. *Procedia - Social and Behavioral Sciences*, *119*, 475–484.
Smith, P. (2014b). BIM implementation - Global strategies. *Procedia Engineering*, *85*, 482–492.
Soust-Verdaguer, B., Llatas, C., & García-Martínez, A. (2017). Critical review of bim-based LCA method to buildings. *Energy and Buildings*, *136*, 110–120.
Succar, B. (2009). Building information modelling framework: A research and delivery foundation for industry stakeholders. *Automation in Construction*, *18*(3), 357–375.
Tommelein, I. D., & Gholami, S. (2012). Root Causes of Clashes in Building Information Models. *Proceedings for the 20th Annual Conference of the International Group for Lean Construction.*, *1*(510), 10. Retrieved from
Uhm, M., Lee, G., & Jeon, B. (2017). An analysis of BIM jobs and competencies based on the use of terms in the industry. *Automation in Construction*, *81*(March), 67–98.
Wang, X., Love, P. E. D., Kim, M. J., Park, C.-S., Sing, C.-P., & Hou, L. (2013). A conceptual framework for integrating building information modeling with augmented reality. *Automation in Construction*, *34*(March), 37–44.
Won, J., & Lee, G. (2016). How to tell if a BIM project is successful: A goal-driven approach. *Automation in Construction*, *69*, 34–43.
Zhao, X., Feng, Y., Pienaar, J., & O'Brien, D. (2017). Modelling paths of risks associated with BIM implementation in architectural, engineering and construction projects. *Architectural Science Review*, *8628*(September), 1–11.

MINIMISING DELAY CONSTRUCTION WASTE IN THE MALAYSIAN CONSTRUCTION INDUSTRY BY USING LEAN CONSTRUCTION TOOLS

Mohd Arif Marhani[1], Aini Jaapar[1], Norazmi Ahmad Bari[1] and Shazwan Mohamed Shaari[2]
[1]Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia.
[2]Faculty of Built Environment, Universiti Malaysia Sarawak, Kota Samarahan, Malaysia.

Abstract
A common underlying cause of construction project hurdles, particularly in developing countries, is avoidable project performance delays. Malaysia is no exception, with nearly 80% of traditionally procured projects experiencing time overruns. Delays can contribute to increased construction costs, lost revenue due to inefficient production, and termination of contract. The Malaysian construction project's planning and cost behaviour outlined that construction projects' total cost behaviour is unsatisfactory, necessitating extreme caution. Lean construction (LC) is suggested as a solution to the problem of construction waste. LC is a construction project continuous quality improvement process that assists a construction company in maintaining profitable growth. This primary research aims to develop an LC tools framework that can enhance the contractor's time performance by minimising construction wastes at the site. The purpose of this paper is to identify the implementation of LC tools in reducing construction waste and determining the most critical LC tools in improving time performance in the Malaysian construction industry. To achieve the objectives of this paper, a quantitative method approach was used, and a questionnaire survey was distributed to 310 contractors in Malaysia. The CIDB directory was being used to recognise the contractors registered with the Construction Industry Development Board Malaysia (CIDB) in the G7 categories. Within eight months, 116 questionnaires were returned, with a response rate of 37.4%. The findings revealed that most LC tools implemented to reduce the delay construction waste were teamwork, concurrent engineering, and management contracts. The results also showed that the top two most critical LC tools that impacted time performance in the Malaysian construction industry were total quality management and teamwork if a construction project faces a delay construction waste. It is hoped that having the LC tools framework will improve time performance and reduce construction project delays. As a result, it can increase future construction productivity and transition from its traditional construction method to a greener and more sustainable approach.

Keywords: *Social media; lean construction; The Malaysian Construction Industry.*

INTRODUCTION

According to Daoud et al. (2020); and Saadi et al. (2016), the construction industry is one of the most important sectors for social and economic development, as well as one of the most important sources of wealth for a country. The outcomes of this industry provide socioeconomic projects and infrastructure facilities such as schools, hospitals, and roads to users. According to Kupusamy et al. (2019), this industry is rapidly developing as a result of modernisation, infrastructure projects, changes in consumption habits, and population growth.

Unfortunately, Ding et al. (2020); Singh and Kumar (2020) emphasised that the construction industry has numerous cost, time, and quality issues that must be addressed. Low quality, cost overruns, delays, and construction waste are all issues in the construction project (Ahuja, 2013; and Mohd Zain et al., 2018). Simultaneously, in their study, (Gunarathne et al., 2018), mentioned that delays are due to government procedures, lengthy contracts and procurement procedures, land acquisitions, construction works and natural climate changes. Nonetheless, construction waste and its impact on the construction industry must be studied.

Besides, according to Fu and Teng (2014), many construction wastes are being produced due to the construction industry's rapid development. This dirty, dangerous and difficult (3D) industry is a massive construction waste producer and solely affects the environment. Equally, this issue arose in the Malaysian construction industry, primarily in order to meet the demands of infrastructure projects (Begum et al., 2007, 2010; Ping et al., 2009). As a consequence, the Malaysian construction industry should indeed undoubtedly change its conventional methods of operation in order to address the issue at hand, in line with the Construction Industry Master Plan (CIMP) 2006-2015, Construction Industry Transformation Programme (CITP) 2016-2020 and the Construction Strategic Plan (Construction Industry Development Board Malaysia, 2007, 2016, 2020). These programmes urged the Malaysian construction industry to use better and more innovative construction methods to support the suitable information technology system.

Therefore, the primary research addresses the construction industry's construction waste issue by presenting the LC tools framework that suit and adaptable to the Malaysian context. The framework also elaborates on how LC tools practice can expand the contractor's time performance. Thus, this paper seeks to identify the implementation of LC tools in minimising delay construction waste and determine the most critical LC tools in enhancing time performance in the Malaysian construction industry. A construction company can improve the time performance of their construction projects by having this LC tools framework, and it is indirectly useful to LC practitioners. As a result, it raises the quality of end products for the industry in the future.

LEAN CONSTRUCTION TOOLS IN MINIMISING DELAY CONSTRUCTION WASTE

The construction industry is crucial for the development and growth of Malaysia's economy. In 2018, the Malaysian construction industry grew at a moderate rate of 4.2% (Central Bank of Malaysia, 2019). The reason why this is happening is due to the shortcoming in the property segment. However, the Central Bank of Malaysia (Central Bank of Malaysia, 2019) added that the civil engineering sub-sector remained the critical driver of growth for the construction sector, supported by infrastructure projects' continued progress. These major infrastructure projects planned in Malaysia, such as intense demand for infrastructure development in Sabah and Sarawak; and the need for more efficient urban transportation, make the construction industry even more critical. Indirectly, it shows that this industry delivers significant employment opportunities in the country. Previously, the industry had a registered workforce of 1.2 million, representing 9.5% of Malaysia's total workforce (Department of Statistics Malaysia, 2013).

Besides, the construction industry is frequently a significant waste generator for the country. Many other countries face a similar problem as the Malaysian construction industry, such as the United Kingdom and Australia. Moreover, according to Nagapan et al. (2012), time and cost overruns are the example of non-physical waste. The Malaysian construction industry has difficulty concentrating on non-physical waste construction projects (Mohammed et al., 2020). Earlier, Shehu et al. (2015) stated that construction projects within Malaysia are overwhelmed by the time and cost overruns that can convert something should have been successful projects, which incur further costs, disputes, litigation, and some examples abandonment of construction projects. In their study, Yap et al. (2020) also refined that a contractor experiences a loss of output and revenues due to missed opportunity of time and cost overruns. Thus, it proves that construction waste, particularly non-physical waste, is the most crucial task that industry players demand to be adequately managed. Through the managed well and minimised the construction wastes, an organisation can save costs and be more profitable. Besides, delays are one construction waste and frequently occurred at the site (Abdul Rahman et al., 2012; Al-Aomar, 2012; Ogunbiyi et al., 2013; Ohno, 1988; Tommelein et al., 2008; Womack & Jones, 2003). Examples of delay are late work delivery, activity start delays, work interruptions and ineffective work. These construction wastes produced at the site not only due to the inadequate management system by the contractor, but most of it also takes place because of adjustments of drawings by the consultant teams.

LC is essentially a large-scale modification of Japanese manufacturing principles, and the concept is applied to construction processes. Ohno (1988) pioneered a simple set of goals for designing the production system in his earlier study. Its goal is to manufacture a car based on customer specifications, deliver it immediately, and have no inventories or intermediate stores (Lim, 2008). Hence, starting from the efforts to reduce machine set up time, this lean production approach has been applied in the Japanese car industry as the key to success from the 1970s to 1980s. Thus, lean production's core concept enables the flow of value steps while eliminating the non-value steps. Hence, according to Wu and Low (2013), the lean production philosophy has verified to be effective in raising the environmental benefits by eliminating waste, preventing pollution, and maximising value to clients. Additionally, even though this approach is evolving year by year, this approach's primary goal is remaining, which is to avoid waste of time, money, and equipment in the construction projects.

LC recommends the simultaneous consideration of the end product and development processes of a construction project. By implementing of LC throughout the life cycle of a project, it has a more precise set of objectives in the delivery process, aiming to maximise the end product's performance (Howell, 1999). Furthermore, Koskela and Howell (2002) added that this approach had established a new management approach to the construction industry. Womack and Jones (2003) expanded on this concept by stating that it can reduce overall expenditures and lead times while preserving quality requirements. Hence, this successful adaptation approach is beneficial to the clients and the communities and the environment itself. The LC approach’s implementation would also gain better results even though it is a complex, uncertain or quick construction project (Salem et al., 2005).

Furthermore, the LC method is a precious strategy to minimise construction waste (Mikulčić et al., 2020). Previously, Magalhães et al. (2017) stated in their study that LC practise must synchronise and organise team members in order to sustain a continuous workflow and eliminate operations that do not add value. This approach produces teamwork and coordinates labour to the best work (Radhika & Sukumar, 2017). Hence, this approach reinforces the best practices by the LC practitioners in the construction industry to intensify project performance (Sarhan et al., 2018).

In their frameworks or guidelines for utilising the LC approach, most earlier researchers recommended specific tools, key concepts, or techniques. This research, however, used the name “LC tools”. These LC tools can be applied throughout construction stages. According to Johansen and Walter (2007), eight focus areas can be identified using these LC tools: procurement, management, planning or control, collaboration, behaviour, design, supply, and installation. Furthermore, the LC tools should be introduced as soon as possible at the earliest stage of the construction projects. This approach also demands the involvement and commitment of all members in a construction project. A construction project can determine the non-value adding activities at an earlier stage, which minimises the construction waste, especially on the non-physical construction wastes. As a result, contractors must classify and comprehend all of the LC tools that can be used in construction activities. According to Jorgensen (2006), in order to embrace project delivery, a construction company requires proper or accurate LC tools that are undeniably equivalent to their requirements. There is no need to utilise all of the LC tools, as most researchers emphasise using the right tool at the perfect time (Suresh et al., 2011). Besides, the LC practitioners need to understand each LC tools' underlying concept to obtain the best result (Abdul Rahman et al., 2012), significantly enhancing their construction processes (Larsson et al., 2013).

This research focuses solely on the impact of LC tools on time performance in a construction project. The time performance has been chosen because it is the core performance that the client always has seen, other than the quality and cost of a construction product. According to Amaitik and Elsagzli (2014); Ikuma et al. (2010); Taubitz (2010); Yu (2010), LC could be measured through the elimination of idle or waiting time in any construction project. Besides, LC could also be measured by analysing and selecting the appropriate material (Chen et al., 2004; Song & Liang, 2011). The literature also stated that integrating LC would result in a smooth project delivery (Fernandez-Solis & Porwal, 2013; Ikuma et al., 2010) and faster construction period (Bashir, 2013; Firmawan et al., 2012; Fullalove, 2013; Monyane et al., 2020; Ogunbiyi, 2014). Hence, these variables are essential in measuring the time performance in every project that implemented the LC approach. Thus, the literature review shows a lack of knowledge of construction wastes, LC tools, and project performances, especially on the time performance.

METHODOLOGY

This research executes a closed-ended questionnaire type, in which the questions outline a set of responses decided by the researchers in advance, as Babbie (2011); Fellows and Liu (2008); Tharenou et al. (2007) stated. Previously, Fellows and Liu (2008); Tharenou et al. (2007) noted that the questionnaire survey could be carried out by hand, email or online. A questionnaire survey is conducted to collect the quantitative data. This research method is designed to get in-depth information regarding the LC approach. The research utilises a 5-point Likert scale, with responses ranging from "never use" to "frequently use" (1 to 5).

The questionnaire survey was created using information obtained from extensive literature reviews involving numerous authors. A questionnaire kit has been prepared to address frequently used technical terms and a scepticism that respondents will understand the words used during data collection. This questionnaire kit defines LC tool terminology and provides examples of how to use them.

The construction companies were used as the unit of analysis for this research. Industrialised Building System (IBS) contractor is the best population since IBS is one of the LC tools that has been assessed in this research. Table Krejcie and Morgan (1970) has been used based on the IBS contractor population. As a result, the research population was drawn from a pool of 1,575 IBS contractors in Malaysia who were registered with the CIDB under the G7 (projects worth more than Ringgit Malaysia 10 million) classifications and defined from the CIDB directory.

The questionnaire was distributed to 310 contractors in Malaysia using stratified random sampling. This stratified random sampling method is a probability sampling method that uses samples from a population subdivided into smaller groups known as strata to reduce costs and improve response efficiency (Saunders et al., 2012; Sekaran, 2006). Because it is a more accurate representation of the overall population, this sampling method yields a more precise metric. Based on the IBS contractor population from the CIDB directory, contractors registered with the CIDB underclass G7 categories were identified. One hundred sixteen questionnaires were returned, making the complete response rate 37.4%. The response rate for postal questionnaires was higher than average in the construction industry, ranging from 20 to 30% (Takim et al., 2004). As a result, this research is optimistic in the respondents' percentage of response rate drawn from a high-quality group.

All of the respondents were LC experts in their respective organizations. They are knowledgeable and committed to participating in and providing input on the LC in the Malaysian construction industry. They have extensive experience managing construction wastes using the LC method. The majority of respondents hold managerial positions and have six to ten years of industry experience, with the majority of respondents involved in commercial projects worth more than RM50 million. As a result, their responses and thoughts are robust to the research findings, and the research's reliability is recognised.

In addition, the IBM Statistical Package for the Social Sciences (SPSS) statistics software version 24 was used to analyse the data for this research. To depict the type and quality of data on respondents and variables, a descriptive statistic is used (Sekaran & Bougie, 2009). Descriptive statistics such as mean (μ), and standard deviation (σX) demonstrate the basic characteristics of the data reported in this research. It can take the form of tables, charts, or graphs. As a result, descriptive analysis is used to show the data in an easy-to-understand and interpret format.

DATA ANALYSIS AND FINDINGS

This section discusses the questionnaire surveys' findings regarding identifying LC tools' potential in reducing delay construction waste in the Malaysian construction industry.

By referring to Table 1, teamwork was preferred in reducing late work delivery (highest $\mu = 2.63$, $\sigma X = 1.386$), while concurrent engineering was favoured in decreasing work interruptions (highest $\mu = 2.64$, $\sigma X = 1.334$). Besides, management contracts were reported could reduce activity start delays, $\mu = 2.59$, $\sigma X = 1.345$ and could reduce ineffective work, $\mu = 2.55$, $\sigma X = 1.398$. Meanwhile, the respondents were not preferred to use standard forms in reducing late work delivery ($\mu = 2.18$, $\sigma X = 1.276$) and industrialised building system in decreasing activity start delays ($\mu = 2.19$, $\sigma X = 1.237$). Furthermore, the 5S process and error proofing, were not desired in reducing work interruptions ($\mu = 2.14$, $\sigma X = 1.229$) and ineffective work ($\mu = 2.17$, $\sigma X = 1.321$).

Table 1. LC Tools' Potential in Reducing Delay Construction Waste

Late Work Delivery			Activity Start Delays			Work Interruptions			Ineffective Work		
LC Tools	**μ**	**σX**	**LC Tools**	**μ**	**σX**	**LC Tools**	**μ**	**σX**	**LC Tools**	**μ**	**σX**
LC15	2.63	1.386	LC2	2.59	1.345	LC4	2.64	1.334	LC2	2.55	1.398
LC4	2.61	1.363	LC6	2.55	1.354	LC7	2.59	1.345	LC16	2.53	1.380
LC3	2.57	1.232	LC3	2.49	1.289	LC6	2.52	1.268	LC1	2.50	1.448
LC6	2.53	1.380	LC15	2.48	1.302	LC15	2.48	1.329	LC15	2.48	1.240
LC2	2.44	1.404	LC7	2.47	1.315	LC3	2.48	1.361	LC11	2.48	1.386
LC11	2.43	1.416	LC19	2.47	1.315	LC14	2.43	1.340	LC10	2.44	1.422
LC14	2.41	1.293	LC11	2.46	1.347	LC2	2.41	1.319	LC6	2.43	1.353
LC10	2.41	1.351	LC17	2.44	1.260	LC16	2.41	1.325	LC7	2.43	1.372
LC7	2.39	1.337	LC16	2.42	1.346	LC1	2.36	1.226	LC17	2.43	1.372
LC16	2.38	1.276	LC10	2.42	1.384	LC13	2.35	1.307	LC3	2.42	1.346
LC5	2.37	1.355	LC18	2.41	1.251	LC10	2.34	1.339	LC4	2.42	1.346
LC13	2.33	1.311	LC5	2.41	1.272	LC5	2.34	1.352	LC8	2.38	1.393
LC18	2.32	1.276	LC12	2.41	1.292	LC8	2.32	1.329	LC18	2.36	1.354
LC8	2.31	1.354	LC4	2.41	1.371	LC18	2.31	1.281	LC19	2.32	1.368
LC12	2.31	1.386	LC9	2.34	1.403	LC17	2.30	1.273	LC14	2.30	1.346
LC19	2.30	1.239	LC13	2.28	1.264	LC12	2.28	1.241	LC5	2.28	1.317
LC20	2.29	1.390	LC14	2.28	1.270	LC9	2.28	1.283	LC9	2.25	1.357
LC17	2.22	1.216	LC1	2.27	1.240	LC11	2.22	1.286	LC20	2.22	1.390
LC9	2.20	1.239	LC8	2.27	1.328	LC20	2.16	1.285	LC12	2.21	1.302
LC1	2.18	1.276	LC20	2.19	1.237	LC19	2.14	1.229	LC13	2.17	1.321

Note: LC1 = Standard Forms, LC2 = Management Contracts, LC3 = Total quality management, LC4 = Concurrent engineering, LC5 = Value-based management, LC6 = Increased visualisation, LC7 = Standardisation of work, LC8 = Last planner system, LC9 = Business process re-engineering, LC10 = Five why's, LC11 = Daily huddle meetings, LC12 = First run studies, LC13 = Error proofing, LC14 = Partnering, LC15 = Teamwork, LC16 = Computer-aided tools, LC17 = Supply chain management, LC18 = Just-in-time, LC19 = The 5S process, LC20 = Industrialised building system

Table 2 indicates the most critical LC tools in reducing delay construction waste in enhancing time performance in the Malaysian construction industry. According to the respondents, implementing total quality management in a construction project would eliminating idle or waiting time (highest $\mu = 2.80$, $\sigma X = 1.210$) and improving time in analysing and selecting the proper material (highest $\mu = 2.96$, $\sigma X = 1.068$). By implementing teamwork, it would be providing smooth project delivery (highest $\mu = 2.87$, $\sigma X = 1.174$) and providing faster construction period (highest $\mu = 2.80$, $\sigma X = 1.172$). Findings from the respondents also stated standards forms was least critical for all the variables for time performance ($\mu = 2.40$, $\sigma X = 1.220$; $\mu = 2.29$, $\sigma X = 1.241$; $\mu = 2.36$, $\sigma X = 1.186$; $\mu = 2.45$, $\sigma X = 1.190$).

Table 2. The Most Critical LC Tools in Reducing Delay Construction Waste in Enhancing Time Performance

Eliminating Idle/waiting Time			**Improving Time in Analysing and Selecting the Proper Material**			**Providing Smooth Project Delivery**			**Providing Faster Construction Period**		
LC tools	**μ**	**σX**	**LC tools**	**μ**	**σX**	**LC tools**	**μ**	**σX**	**LC tools**	**μ**	**σX**
LC3	2.80	1.210	LC3	2.96	1.068	LC15	2.87	1.174	LC15	2.80	1.172
LC7	2.74	1.163	LC18	2.82	1.208	LC3	2.80	1.101	LC3	2.74	1.075
LC2	2.73	1.203	LC6	2.77	1.200	LC17	2.78	1.183	LC18	2.74	1.118
LC15	2.69	1.293	LC15	2.77	1.220	LC18	2.73	1.142	LC2	2.70	1.038
LC18	2.66	1.293	LC2	2.76	1.122	LC2	2.72	1.186	LC20	2.70	1.321
LC5	2.64	1.219	LC16	2.75	1.255	LC14	2.70	1.201	LC7	2.69	1.203
LC13	2.63	1.140	LC16	2.74	1.231	LC7	2.70	1.233	LC16	2.68	1.121
LC17	2.61	1.187	LC4	2.71	1.237	LC5	2.69	1.243	LC10	2.67	1.129
LC14	2.57	1.222	LC5	2.69	1.283	LC19	2.69	1.261	LC12	2.66	1.117
LC19	2.56	1.339	LC19	2.67	1.309	LC16	2.67	1.119	LC4	2.65	1.101
LC10	2.55	1.200	LC20	2.65	1.402	LC4	2.67	1.161	LC6	2.65	1.141
LC4	2.54	1.207	LC9	2.64	1.210	LC13	2.63	1.171	LC5	2.64	1.199
LC6	2.52	1.212	LC8	2.63	1.236	LC6	2.61	1.222	LC19	2.64	1.235
LC12	2.52	1.214	LC7	2.63	1.284	LC20	2.61	1.340	LC14	2.63	1.170
LC8	2.52	1.237	LC14	2.61	1.163	LC12	2.60	1.185	LC17	2.61	1.123
LC9	2.50	1.206	LC10	2.60	1.236	LC9	2.56	1.178	LC13	2.61	1.137
LC16	2.48	1.199	LC11	2.56	1.240	LC8	2.56	1.182	LC8	2.57	1.185
LC20	2.47	1.395	LC12	2.56	1.251	LC11	2.55	1.162	LC9	2.53	1.141
LC11	2.46	1.189	LC13	2.54	1.217	LC10	2.53	1.225	LC11	2.49	1.142
LC1	2.40	1.220	LC1	2.29	1.241	LC1	2.36	1.186	LC1	2.45	1.190

Note: LC1 = Standard Forms, LC2 = Management Contracts, LC3 = Total quality management, LC4 = Concurrent engineering, LC5 = Value-based management, LC6 = Increased visualisation, LC7 = Standardisation of work, LC8 = Last planner system, LC9 = Business process re-engineering, LC10 = Five why's, LC11 = Daily huddle meetings, LC12 = First run studies, LC13 = Error proofing, LC14 = Partnering, LC15 = Teamwork, LC16 = Computer-aided tools, LC17 = Supply chain management, LC18 = Just-in-time, LC19 = The 5S process, LC20 = Industrialised building system

DISCUSSION

Teamwork, concurrent engineering, and management contracts were the most widely used LC tools in the Malaysian construction industry for reducing construction delay and waste. As a result, it demonstrates three of the eight focus areas of LC tools in reducing the delay construction waste. The three focus areas are procurement (management contracts), management (concurrent engineering) and behaviour area (teamwork). In contrast, Johansen and Walter (2007) suggested a construction company incorporate eight focus areas in implementing the LC tools. As a result, it demonstrates that, despite the fact that the LC practitioners in Malaysia applied three focus areas in reducing delay construction waste, the practitioners still benefit from the implementation of LC. The three focus areas are effectively implemented in organisations and successfully embrace the flow delivery of their construction projects. As Jorgensen (2006) agreed, an organisation only requires appropriate or suitable LC tools when implementing LC in their organisation. LC practitioners can still reap the benefits of LC by using a specific tool at a specific time.

Furthermore, in the Malaysian construction industry, total quality management and teamwork were the most important LC tools that influenced time performance. It demonstrates that these two areas, management (total quality management) and behaviour (teamwork), were the most effective LC tools for improving time performance if the construction project is delayed. Despite the fact that Johansen and Walter (2007) proposed that an organisation should incorporate eight focus areas during the implementation of LC tools, the findings show that less is still enough to improve time performance. As a result, it confirms Suresh et al. (2011)'s statement that it is not necessary to use all of the LC tools, and the authors agreed. The right and appropriate decisions on selecting and utilising the LC tools are critical to the organisation's ability to remain active, sustainable, competitive, and growing.

CONCLUSIONS

The top three most LC tools implemented to reduce the delay construction waste were teamwork, concurrent engineering, and management contracts. Thus, it indicates that in reducing the delay construction waste in the Malaysian construction industry, three out of eight focus areas of LC tools, procurement, management, and behaviour area have been implemented. It also displays that even though the LC practitioners implemented these three focus areas in reducing delay construction waste, the LC practitioners can still manage and improve the construction process.

Furthermore, the top two most critical LC tools that impacted time performance in the Malaysian construction industry were total quality management and teamwork. Thus, two out of eight focus areas of LC tools: management and behaviour implemented during the construction process. It also demonstrates that the most important things for a construction company to choose appropriate or suitable LC tools that efficiently grasp the project delivery.

In addition, this research contributes a crucial review of existing literature on delay construction waste, LC tools, and time performance, leading to a comprehensive overview of related studies. This research also contributes to construction industry practices. Achieving growth in project performance is becoming a priority in every construction project, especially on-time performance. This research can improve the contractor’s time performance in eliminating idle/waiting time, improving time in analysing and selecting the appropriate material, providing smooth project delivery and providing a faster construction period.

ACKNOWLEDGMENT

This research was supported by a grant from Lestari Research Grant Scheme (600-IRMI 5/3/LESTARI (019/2018)) funded by the Universiti Teknologi MARA, Shah Alam, Selangor.

REFERENCES

Abdul Rahman, H., Wang, C., & Lim, I. Y. W. (2012). Waste processing framework for non-value-adding activities using lean construction. *Journal of Frontiers in Construction Engineering*, *1*(1), 8–13. http://www.academicpub.org/fce/paperInfo.aspx?ID=3

Ahuja, R. (2013). Sustainable construction: is lean green? *International Conference on Sustainable Design,Engineering and Construction*, 903–911. http://ascelibrary.org/doi/pdf/10.1061/9780784412688.108

Al-Aomar, R. (2012). Analysis of lean construction practices at Abu Dhabi construction industry. *Lean Construction Journal*, 105–121. http://www.leanconstruction.org/media/docs/lcj/2012/LCJ_12_006.pdf

Amaitik, N., & Elsagzli, N. (2014). A study of lean principles implementation in the Libyan healthcare and industry sectors. *Waset.Org*, *8*(1), 1–12.

Babbie, E. R. (2011). *Introduction to social research* (5th ed.). Wadsworth.

Bashir, A. M. (2013). *A framework for utilising lean construction strategies to promote safety on construction sites* [University of Wolverhampton]. http://wlv.openrepository.com/wlv/handle/2436/297665

Begum, R. A., Satari, S. K., & Pereira, J. J. (2010). Waste generation and recycling: comparison of conventional and industrialized building systems. *American Journal of Environmental Sciences*, *6*(4), 383–388.

Begum, R. A., Siwar, C., Pereira, J. J., & Jaafar, A. H. (2007). Factors and values of willingness to pay for improved construction waste management-a perspective of Malaysian contractors. *Waste Management (New York, N.Y.)*, *27*(12), 1902–1909. https://doi.org/10.1016/j.wasman.2006.08.013

Central Bank of Malaysia. (2019). Annual report of 2018. In *Central Bank of Malaysia* (Issue March). https://doi.org/10.1111/j.1755-6988.1986.tb00583.x

Chen, Q., Wakefield, R., & O'Brien, M. (2004). Lean applications on residential construction site. *Specialty Conference on Leadership and Management in Construction*, 1–14. http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Lean+Applications+on+Residential+Construction+Site#4

Construction Industry Development Board Malaysia. (2007). *Construction Industry Master Plan 2006-2015 (CIMP)*.

Construction Industry Development Board Malaysia. (2016). Construction Industry Transformation Programme (CITP) 2016-2020. In *Construction Industry Development Board Malaysia*. https://doi.org/10.11113/jt.v78.4056

Construction Industry Development Board Malaysia. (2020). *Construction 4.0 strategic plan (2021-2025) next revolution of the Malaysian construction industry*.

Daoud, A. O., Othman, A. A. E., Robinson, H., & Bayyati, A. (2020). An investigation into solid waste problem in the Egyptian construction industry: a mini-review. *Waste Management and Research*, *38*(4), 371–382. https://doi.org/10.1177/0734242X20901568

Department of Statistics Malaysia. (2013). *Statistics of employment*. Department of Statistics Malaysia.

Ding, C. S., Salleh, H., & Kho, M. Y. (2020). Constructability research trends: a review and future directions. *International Journal of Sustainable Construction Engineering & Technology*, *11*(1), 7–17.

Fellows, R., & Liu, A. (2008). *Research methods for construction*. Blackwell Publishing Ltd.

Fernandez-Solis, J., & Porwal, V. (2013). Survey of motivations, benefits, and implementation challenges of last planner system users. *Journal of Construction Engineering and Management*, *April*, 354–360. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000606.

Firmawan, F., Othman, F., & Yahya, K. (2012). Improving project performance and waste reduction in construction projects: a case study of government institutional building project. *International Journal of Technology*, *2*, 182–192. http://www.ijtech.eng.ui.ac.id/index.php/journal/article/download/93/66.

Fu, Q., & Teng, J. (2014). Analysis of the construction cost management based on the perspective of the construction waste recycling. *International Conference on Management Science and Management Innovation (MSMI 2014), Msmi*, 701–706. http://www.atlantis-press.com/php/download_paper.php?id=13004.

Fullalove, L. (2013). Examples of lean techniques and methodology applied to UK road schemes. *21st Annual Conference of the International Group for Lean Construction*, 1057–1066.

Gunarathne, A., Zainudeen, N., & Perera, C. (2018). A review on integrating value engineering and sustainability in construction: improving project value in Sri Lankan construction projects. *Annual Technical Session 2018 Institute of Quantity Surveyors Sri Lanka*, *January*, 1–82.

Howell, G. A. (1999). What is lean construction-1999. *Proceedings IGLC-7*, 1–10.

Ikuma, L. H., Nahmens, I., & James, J. (2010). Use of safety and lean integrated kaizen to improve performance in modular homebuilding. *Journal of Construction Engineering and Management*, *July*, 551–560. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000330.

Johansen, E., & Walter, L. (2007). Lean construction: prospects for the German construction industry implementation of lean concepts in construction. *Lean Construction Journal*, *3*(April), 19–32.

Jorgensen, B. (2006). *Integrating lean design and lean construction: processes and methods*. The Technical University of Denmark.

Koskela, L., & Howell, G. (2002). The theory of project management: explanation to Novel methods. *International Group for Lean Construction*, 1–11.

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

Kupusamy, K., Nagapan, S., Abdullah, A. H., Kaliannan, S., Sohu, S., Subramaniam, S., & Maniam, H. (2019). Construction waste estimation analysis in residential projects of Malaysia. *Engineering, Technology and Applied Science Research*, *9*(5), 4842–4845.

Larsson, J., Eriksson, P. E., Olofsson, T., & Simonsson, P. (2013). Industrialized construction in the Swedish infrastructure sector: core elements and barriers. *Construction Management and Economics*, *October 2013*, 1–14. https://doi.org/10.1080/01446193.2013.833666.

Lim, V. (2008). *Lean construction: knowledge and barriers in implementing into Malaysia construction industry* (Issue November) [Universiti Teknologi Malaysia]. http://eprints.utm.my/9590/

Magalhães, R., Mello, L., & Bandeira, R. (2017). Planning and control of civil works: multiple case study in Rio de Janeiro construction companies. *Gestão & Produção*.

Marhani, M. A., Nor Azmi, A. B., & Aini, J. (2019). The effectiveness of lean construction tools in the Malaysian construction industry towards contractor's environmental performance. *MATEC Web of Conferences*, *266*, 1–7.

Mikulčić, H., Baleta, J., & Klemeš, J. J. (2020). Sustainability through combined development of energy, water and environment systems. *Journal of Cleaner Production*, *251*, 119727. https://doi.org/10.1016/j.jclepro.2019.119727.

Mohammed, M., Abdallah, N. A. W., Ayoub, M., & Haruna, A. (2020). A review on achieving sustainable construction waste management through application of 3R (reduction, reuse, recycling): a lifecycle approach. *IOP Conference Series: Earth and Environmental Science*, *476*, 1–9. https://doi.org/10.1088/1755-1315/476/1/012010

Mohd Zain, A. F., Hasmori, M. F., Nagapan, S., Abdullah, A. H., & Yunus, R. (2018). A review of construction management practices in minimizing on-site construction waste. *Journal of Advanced Research in Dynamical and Control Systems*, *10*(6), 9–14.

Monyane, T., Emuze, F., Awuzie, B., & Crafford, G. (2020). Challenges to lean construction implementation in South Africa. In *The Construction Industry in the Fourth Industrial Revolution* (pp. 337–344). https://doi.org/10.1017/CBO9781107415324.004

Nagapan, S., Abdul Rahman, I., & Asmi, A. (2012). Factors contributing to physical and non-physical waste generation in construction industry. *International Journal of Advances in Applied Sciences*, *1*(1).

Ogunbiyi, O. (2014). *Implementation of the lean approach in sustainable construction: a conceptual framework* (Issue April) [University of Central Lancashire]. http://clok.uclan.ac.uk/10563/2/Ogunbiyi Oyedolapo Final e-Thesis (Master Copy).pdf

Ogunbiyi, O., Oladapo, A., & Goulding, J. (2013). A review of lean concept and its application to sustainable construction in the UK. *International Journal of Sustainable Construction Engineering & Technology*, *4*(2), 82–92. http://penerbit.uthm.edu.my/ojs/index.php/IJSCET/article/view/687

Ohno, T. (1988). Toyota Production System: Beyond Large-Scale Production. *Productivity Press*, 152. https://doi.org/10.1108/eb054703

Ping, T., Omran, A., & Pakir, A. (2009). Material waste in the Malaysian construction industry. *Itchannel.Ro*, *November*, 257–264. http://www.itchannel.ro/faa/257_pdfsam_ICEA_FAA_2009.pdf

Radhika, R., & Sukumar, S. (2017). An overview of the concept of lean construction and the barriers in its implementation. *International Journal of Engineering Technologies and Management Research*, *4*(3), 13–26. https://doi.org/10.5281/zenodo.478010

Saadi, N., Ismail, Z., & Alias, Z. (2016). A review of construction waste management and initiatives in malaysia. *Journal of Sustainability Science and Management*, *11*(2), 101–114. https://www.scopus.com/inward/record.uri?eid=2-s2.085012937499&partnerID=40&md5=209680d6cc4e37b042dadd75c9bf9971

Salem, O., Solomon, J., Genaidy, A., & Luegering, M. (2005). Site implementation and assessment of lean construction techniques. *Lean Construction Journal*, *2*(October), 1–58.

Sarhan, J., Xia, B., Fawzia, S., Karim, A., & Olanipekun, A. (2018). Barriers to implementing lean construction practices in the Kingdom of Saudi Arabia (KSA) construction industry. *Construction Innovation*, *18*(2), 246–272. https://doi.org/10.1108/CI-04-2017-0033

Saunders, M., Lewis, P., & Thornhill, A. (2012). *Research methods for business students* (5th ed.). Pearson.

Sekaran, U. (2006). *Research methods for business students: a skill building approach* (4th Ed.). John Wiley & Sons.

Sekaran, U., & Bougie, R. (2009). *Research Methods for Business A Skill Building Approach* (Fifth ed.). John Wiley & Sons.

Shehu, Z., Holt, G. D., Endut, I. R., & Akintoye, A. (2015). Analysis of characteristics affecting completion time for Malaysian construction projects. *Built Environment Project and Asset Management*, *5*(1), 52–68. https://doi.org/10.1108/BEPAM-10-2013-0056

Singh, S., & Kumar, K. (2020). Review of literature of lean construction and lean tools using systematic literature review technique (2008-2018). *Ain Shams Engineering Journal*, *11*, 465–471. https://doi.org/10.1016/j.asej.2019.08.012

Song, L., & Liang, D. (2011). Lean construction implementation and its implication on sustainability: a contractor's case study. *Canadian Journal of Civil Engineering*, *38*(3), 350–359. https://doi.org/10.1139/L11-005

Suresh, S., Bashir, A., & Olomolaiye, P. (2011). A protocol for lean construction in developing countries. In *Contemporary Issues in Construction in Developing Countries* (pp. 376–405). Taylor & Francis Ltd.

Takim, R., Akintoye, A., & Kelly, J. (2004). Analysis of measures of construction project success in Malaysia. *20th Annual ARCOM Conference*, *2*, 1123–1133. https://doi.org/10.5539/ass.v4n7p74

Taubitz, M. A. (2010). Lean, green & safe. *Professional Safety*, 39–46.

Tharenou, P., Donohue, R., & Cooper, B. (2007). *Management research methods*. Cambridge University Press.

Tommelein, I. D., Ballard, G., & Kaminsky, P. (2008). Supply chain management for lean project delivery. In W. J. O'Brien, C. T. Formoso, R. Vrijhoef, & K. A (Eds.), *Construction Supply Chain Management Handbook* (pp. 6-1-6–22). LondonCRC Press.

Womack, J., & Jones, D. (2003). *Lean thinking - banish waste and create wealth in your corporation*. Free Press.

Wu, P., & Low, S. P. (2013). *Lean and cleaner production - applications in prefabrication to reduce carbon emissions*. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-42062-7

Yap, J. B. H., Goay, P. L., Woon, Y. B., & Skitmore, M. (2020). Revisiting critical delay factors for construction: analysing projects in Malaysia. *Alexandria Engineering Journal*. https://doi.org/10.1016/j.aej.2020.11.021

Yu, H. (2010). *An integrated approach toward lean for production homebuilders*. University of Alberta.

RISK ALLOCATION FOR DIFFERENT PROCUREMENT TYPE IN MALAYSIAN CONSTRUCTION INDUSTRY

Nurhuda Athira Zainudin[1], Hamimah Adnan[1], Wan Norizan Wan Ismail[2], Har Einur Azrin Baharuddin[1] and Zul Zakiyuddin Ahmad Rashid[3]
[1]Department of Built Environment Studies and Technology, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA Perak Branch, Seri Iskandar, Perak, Malaysia.
[2]Faculty of Architecture, Planning and Surveying, University Teknologi MARA, Shah Alam, Selangor, Malaysia.
[3]School of Housing, Building and Planning, Universiti Sains Malaysia,11800 USM, Pulau Pinang Malaysia.

Abstract
Risk allocation is one of the important aspect in risk management. However, there is a tendency that risks in construction are being allocated to parties that are least able to resist taking on the risk rather than parties that are more capable to manage the risks. There are different types of procurement that led to different approaches in settling risk allocation between contracting parties. This paper aims to identify risk allocation for different procurement types in construction projects focusing on traditional, design-build and public-private partnership procurement. For this research, a quantitative method was used, where 354 sets of questionnaires were distributed to selected construction firms in Klang Valley. Ninety two (92) sets of questionnaires were returned and analyzed and the respondents were asked to rate the probability of risk occurrence. The result indicated that the top ranked risk factors are 'unstable government', 'delay in project approvals and permits', 'fluctuation of material cost', 'poorly written contract' and 'inadequate specification in contract'. The recommended risk allocation by respondent for each procurement is presented and found that client and contractor in Traditional procurement, the risks are allocate based on its nature of work. In Design-build, risk factors are mainly allocated to contractor. While in PPP, both contracting parties prefer the majority of the risk factors to be shared. The results of this research will assist practitioners in allocating risks to the party that most qualified to analyze, control, and manage these risks.

Keywords: *Risk allocation; procurement; construction.*

INTRODUCTION

Risks in the construction industry are inseparable due to the complexity of coordinating numerous operations and parties, and as it impacted by a wide variety of internal and external factors (Ashmawi et al., 2018). There is a limitation in terms of cost, time, and quality which affect the project success (Jaber, 2010). Construction projects are subjected to unexpected events that may affecting the project's success. These uncertainty events are called risks and they must be identified, assessed and allocated so that responsibility to bear the risk will be appropriate and effective and the parties involved are able to gain benefit. Over the last few years, there has been a rise of interest in construction industry players to implement various types of procurement instead of just using Traditional procurement. Each type of procurement lead to dissimilar approach in settling the risk allocation between contracting parties. However, there is a tendency that risks in construction are not being allocated to the parties best able to control the risks, but rather to the parties that least able to resist taking on the risks (Shrestha et al., 2015). As a result, it increases the chances for the project to fail as the risk is transferred to the party that is less capable to control the risk. Therefore, there is increasing concern that some risks are being allocated inappropriately making one party at loss.

Furthermore, limited provisions on risk allocation, as well as differences in culture and working practices, are also likely to affect proper risk allocation (Hwang and Yu, 2016). Zulhafiz (2018) mentioned that sometimes there is an imbalance in bargaining power between the parties, with the weaker party (typically the contractor) being denied the ability to argue or negotiate risk allocation. Ashmawi et al. (2018) mentioned that if risk is allocated inappropriately between client and contractor, it will likely harm the relationship between both parties and can result conflict, litigation and increasing bid price.

The research to date tended to focus risk allocation in PPP procurement rather than any other type of procurement because the PPP procurement itself has always focused on risk sharing between government and private party. There is a substantial gap in current literature that generates a need for this study to be carried out. From this standpoint, risk allocation is also significant to be highlighted in other types of procurement. Therefore, this study aims to investigate risk allocation for different procurement type in construction industry and to recommend risk allocation between client and contractor.

LITERATURE REVIEW

Procurement System

In construction, procurement describes the processes of acquiring constructed facilities that begin with the project initiation stage and proceed until the project completion stage of the finished facilities, where each type of procurement has its own characteristics in structuring the processes (Abdul Rashid and Khairuddin, 2017). According to Ismail, Isa and Yusop (2018), the implementation of appropriate procurement system is very significant in project performance as it will likely contribute in successful project delivery. Generally, procurement can be categorized into two classifications which are Traditional and Non-traditional procurement system where the Non-traditional procurement system is implied to procurement method other than the Traditional (Richard, Luqman and Nurayn, 2015).

Traditional procurement has existed as the only available method to acquire built facilities in construction industry for many years (Richard, Luqman and Nurayn, 2015). This procurement is widely use in Malaysian construction industry and able to satisfy major project requirement. According to Siah (2020), this method is well known due to the separation of design and construction process. Although its popularity has declined as a result of the introduction of other alternatives procurement, traditional procurement are still favoured by many clients in construction projects.

Shrestha and Fernane (2017) described Design-build method as a client that enters into a contract with a contractor that will in charge for both the design and the construction of the project. In this procurement method, the project usually is carried out on a lump sum fixed price (Rahmani, Tayyab and Khalfan, 2017). This single point of responsibility on the contractor enables construction work to be start without completion of design (Park and Kwak, 2017). According to Salla (2020) the design provided by the contractor usually limited to the contractor's capabilities and resources, which will outweigh the client's design requirements. Thus, in terms of suitability, Design-build is suitable to be applied on large, complex, environmentally uncertain and specialized project where requires an experienced contractor.

PPP have emerged as a strategic instrument to enhance the quality and effectiveness of public infrastructure and to make operations more efficient especially in developing countries such as Malaysia as it involved public and private sector to team up and shares knowledge, skills and resources (Keers and Fenema, 2018). In PPP projects, a private concessioner designs, builds and maintains the facility. After the concession period, the ownership then will be transferred to government (Ahmad, Ibrahim and Bakar, 2018). It is generally recognized that a PPP procurement is a type of joint venture between the public and private sectors aimed at achieving social and economic goals via collaboration, which involves risk sharing of projected costs and expected profits (Loosemore and Cheung, 2015).

Risk Allocation

Jaber (2019) defines risks as uncertain occurrences that if they occur, have a detrimental or beneficial effect on at least one of the construction project's objectives. A risk may have one or more causes and it may have one or more implications if it arises. Violante, Dominguez and Paiva (2018) said that every risk factors should be identified, analyzed and evaluated in such a manner that the control measure can be immediately preceded. When risk is well understood, it allows parties to prepare steps to reduce their negative impacts (El-Sayegh and Mansour, 2015). Contract conditions will reflect the provisions that allocates responsibilities among contracting parties as stated by Ashmawi et al. (2018).

One of the strategy to handle risks is good practice of risk allocation. It assigned the responsibility for managing the implications of each risk to one of the contracting parties, or it agreed to deal with the risk through a predefined procedure, which may include risk sharing (Hissayat et al., 2020). According to Hwang and Yu (2016), risk allocation is the process of assigning identified risk between parties in the project where it divides the responsibility related with a possible loss or gain. The principle in risk allocation is risk will be transferred towards party that the most capable to handle it (Ashmawi et al., 2018). According to Shrestha et al. (2018), for risks to be efficiently allocated in a project, some risks have to be shared, with both parties taking responsibility in handling them.

Risk allocation in Traditional procurement as mentioned by Siaw (2016), the client will likely take the risk factors associated with design whereas the contractor takes that associated with construction. In traditional procurement most of the risks were allocated to the owner and few were allocated directly to the contractor. O'shea, Palcic and Reeves (2018) agree with this assertion, stating that under traditional forms of procurement, the client bears the majority of project risks. This includes contract risks, political hazards, and payment-related concerns such as progress payments, which are typically managed by the client. Contractors, on the other hand, handle risks associated with the construction process such as supplier, subcontracting, labour, plant, and machinery. As soon as the contractor receives the site from the client, he is liable for the site, everything on it, and the method and resources he considers needed to accomplish the work (Ashmawi et al., 2018).

Due to insufficient of knowledge and expertise in risk allocation management, clients in design-build projects prefer to transfer more risk to the contractor, and contractors act by raising their margin of contingencies amount, causing the contract amount to eventually increase. According to Salla (2020), in design-build procurement, risk for the owner is low while risk for the contractor is high due complete involvement from contractor during design and construction. Lee, Rahman and Doh (2018) explained that the contractor in design-build procurement is required to bear huge risks in designing, constructing, and managing the project. According to Burkhauser, Butler and Kim (2016), the client has little authority on the construction program, unless the contract requirements specify the client's contribution or the client chooses to pay the contractor for the ability to manage the plan as a change to the agreement.

In PPP project the client is government sector while private sector is the one who hires, pays and supervise the contractor. Almarri, Alzahrani and Boussabaine (2019) found that most of exogenous risk factors are usually managed by the private sector. This statement is also supported by Rafaat et al. (2020) which said that the private partner holds responsibility for finance, construction, maintenance, operation and use of the infrastructure facility. However, for financial risk Shrestha and Fernane (2017) suggested that economy risk should be allocated to the government sector. This says that the government have to cover the loss incure by the private sector due to economic factor such as inflation. For risk to be efficiently allocated in PPP project, risk should not be handle by the private sector alone, instead a few risks can be transferred to the government or shared. Rafaat et al. (2020) said that majority of experts preferred that some of the risks to be shared, mainly concerning the inflation rate, interest rate and foreign rate risks. Rafaat et al. (2020) also said that where risk is beyond the control of either public or private partner such as Force majeure should be borne by both public and private sector.

METHODOLOGY

This study begin with defining the research problem clearly which contains precise issues followed by a literature review where it covers the concept and theories on risk allocation and procurement method in construction industry. The survey questionnaire is revised based on information derived from the systematic literature review with the pilot test for comments from the expertise in risk allocation.

Quantitative research is adopted for this research are questionnaires survey distributed as a means of data collection to 354 construction firms based on population and sample size that has been identified. Clients, consultants and contractors in construction firms located in Klang Valley were choose as the targeted population for this study. The location is focussing on Klang Valley as it is the hub of Malaysia's industry, with the majority of firms headquartered there. For clients, this research targeted both Public and Private firms. The study also targeted the G7 contractors and other three prominent consultants in the construction industry: architects, engineers, and quantity surveyors.

The questionnaires listed a total of 38 risks factors that are categorized based on their nature derived from the literature (Hwang and Yu, 2016); (Mohamed et al., 2015); (Shrestha and Fernane, 2017); and (Siaw, 2016). Respondents were asked to rate probability of risk occurrence in construction industry based on a 5-point likert scale (where 1 = very low probability, 2 = low probability, 3 = moderate probability, 4 = high probability and 5 = very high probability). This 5-point likert scale was also adopted by other researcher like Siaw (2016) to study the probability and impact of risk in their research.

RESULT AND DISCUSSION

Respondent's Demographic

In this research, the majority of respondents coming from private sector were 85 number of respondents. While only 7 respondents were from the public sector. Majority of the respondents coming from client/developer recorded 34% of the number of respondents. Then it is followed by contractor, which represented the second largest of respondent consisting 25% of respondents. Engineering firm recorded 16% and 13 number of respondents coming from Quantity Surveyor firm. The least percentage is Architecture firm which recorded only 12 respondents (12%).

The majority of the respondents working as developer/client were 28 respondents (31%). Quantity surveyors placed third highest of role among the respondents as 19% involved in this survey while Architect represented 11% of the respondents. It shows that, Engineer for both Civil & Structural Engineer and Mechanical & Electrical Engineer as lowest number of respondents with 12% (11 respondents) followed by the lowest percentage 5% (5 respondents).

The respondents with 11 to 20 years of experience in the industry recorded the highest percentage which is 39%. This is beneficial to the study as the respondents who answered the questionnaire are experienced in the field. Second highest are respondents with experience less than 5 years which recorded 31%. Almost every respondent has been involved in Traditional procurement which is 95.7%. This is because, Traditional procurement remains as the most common method of procurement in Malaysian construction industry. Design-build procurement recorded 60.9%. The least type of procurement which respondents have been involved in is PPP where it only recorded 55.4%.

Level of Risk Occurrence

Table 1 shows that risk factor with the highest level of occurrence is unstable government received the highest Mean 4.22. Unstable government is a major risk in Malaysian construction industry as the political crisis is likely to influence infrastructure development. Unstable government is a major risk. Investors, particularly those from foreign countries, are likely to put their investment plans on hold as it is risky to invest in the country with unstable political situations. The second risk factor is delay in project approval and permits (Mean 4.09). Delay is one of the problems affecting planning and building plan applications. Fluctuation of material cost (Mean 4.08) is the third highest risk to occur and it has effect towards many parties, not just supplier and developer but also property buyer.

The fourth highest risk to occur is poorly written contract (Mean 4.03). Poorly written contract will adversely affect the construction project as it causes claim problems and can cause major variation. Next, inadequate specification in contract (Mean 4.02) ranked on the fifth highest risk to occur. This risk factor has relation with previous risk factor (poorly written contract). When client provide inadequate specification in contract, contractor may take advantage by using lower grade materials to maximize profit. Mistake during construction are in sixth highest risk occurrence (Mean 3.99). As said by Kog (2019), rework due to mistakes in construction are common problems associated with contractor. The seventh highest risk is insufficient time for completion date (Mean 3.98).

The sixth ranked risk factor is Incompetent sub-contractor (Mean 3.93). Globally, subcontractor related issues are always a problem, it is no exception in Malaysia. One of the reasons is due to the criteria used to hire subcontractor in initial project differed with the criteria used in choosing sub-contractor during construction stage (Lew et al., 2018). Then, in ninth place is project funding problem (Mean 3.90). Funding problem is one of the risk factors related to client/developer. From this analysis it can be determined that client/developer has high exposure towards project funding problems. The tenth risk factor is delays in construction project (Mean 3.83). According to Yap et al. (2020), the contributors to delays are lack of proper planning, scheduling and a lot amount of variation orders.

Table 1. Top 10 Risk Factor based on its Probability Level of Occurrence

Rank	Risk Factor	Mean	Probability
1	Unstable government	4.22	Very high
2	Delay in project approvals and permits	4.09	Very high
3	Fluctuation of material cost	4.08	Very high
4	Poorly written contract	4.03	Very high
5	Inadequate specification in contract	4.02	Very high
6	Mistake during construction	3.99	Very high
7	Insufficient time for completion date	3.98	Very high
8	Incompetent sub-contractor	3.93	Very high
9	Project funding problems	3.90	Very high
10	Delays in construction	3.83	Very high

Risk Allocation in Traditional Procurement

Table 2. Comparison of Risk Allocation between Traditional, Design-Build and PPP Procurement

Rank	Risk Factor	Risk Allocation		
		Traditional	Design-build	PPP
FINANCIAL				
9	Project funding problems	Client	Contractor	Shared
11	Inadequate cash flow by contractor	Shared	Contractor	Contractor
27	Client financial capability	Shared	Contractor	Client
ECONOMICS				
3	Fluctuation of material cost	Contractor	Contractor	Shared
20	Unpredicted changes in interest rate	Shared	Shared	Shared
22	Exchange rate fluctuation	Client	Shared	Shared
23	Inflation rate	Shared	Contractor	Shared
33	Changes of market demand	Client	Shared	Shared
POLITICAL				
1	Unstable government	Client	Client	Client
2	Delay in project approvals and permits	Client	Shared	Shared
13	Inconsistencies in government policies	Client	Shared	Client
CONSTRUCTION				
6	Mistake during construction	Contractor	Contractor	Shared
7	Insufficient time for completion date	Contractor	Contractor	Undecided
8	Incompetent sub-contractor	Contractor	Contractor	Contractor
10	Delays in construction	Contractor	Contractor	Contractor
14	Quality of construction	Contractor	Contractor	Contractor

Rank	Risk Factor	Risk Allocation		
		Traditional	Design-build	PPP
TECHNICAL				
15	Changes in design	Shared	Contractor	Client
18	Errors of original design	Client	Shared	Client
21	Insufficient of original design	Client	Shared	Client
26	Complexity of design	Client	Shared	Client
ENVIRONMENT				
16	Weather	Shared	Shared	Shared
36	Force majeure	Shared	Shared	Shared
37	Pollution	Shared	Shared	Shared
SOCIAL				
25	Insecurity and crime	Client	Shared	Shared
28	Disturbance to public activities	Shared	Shared	Shared
30	Land acquisition and compensation problem	Client	Client	Undecided
HEALTH AND SAFETY				
12	Inadequate safety measure on unsafe operation	Contractor	Contractor	Contractor
17	Accidents occurring during constructions	Contractor	Contractor	Contractor
29	Epidemic illness	Shared	Shared	Shared
CONTRACTUAL				
4	Poorly written contract	Client	Shared	Shared
5	Inadequate specification in contract	Client	Shared	Shared
RESOURCES				
19	Lack in availability of equipment	Contractor	Contractor	Contractor
32	Equipment breakdown	Contractor	Contractor	Contractor
34	Supplies of defective materials	Contractor	Contractor	Shared
35	Late deliveries of materials	Contractor	Contractor	Contractor
SITE CONDITION				
24	Late construction site possession	Client	Contractor	Shared
31	Inadequate site investigations	Contractor	Client	Contractor
38	Unpredicted adverse subsurface condition	Shared	Contractor	Shared

Table 2 shows the risk factors that have been allocated suggested by respondents. Using percentage method, the data is presented in table form. As suggested by El-Sayegh and Mansour (2015), risk will be allocated to the party that receives more than 50% respondent's suggestion. If risk failed to have at least 50%, the risk will be categorized as 'undecided'.

In Traditional procurement, risks are allocated to the parties based on the nature of the work itself. Risk factors that associated with contractor such as 'Mistake during construction', 'Incompetent sub-contractor', 'Quality of construction' are allocated to contractor as contractor have the most capability and knowledge to control these kinds of risks. These findings are agreed by Ashmawi et al. (2018) saying that it is rational to allocate such risks under contractors' responsibility because contractor is the sole party who can exercise control over the construction issues related to sub-contractor or quality.

Conversely, risks that have been allocated other than contractor, are either out of contractor's control or the client may also have control over it. Study revealed that risk factors listed under the technical, political and contractual are mainly shifted to client's responsibility. These risk factors are perceived to be better allocated to client because it is under client's control although these are under consultant's duty but according to El-Sayegh and Mansour (2015), as the client employed consultant as client's representative, hence the risk for this category are eventually allocated to the client. Thus, risk allocation suggested by respondents in this study for Traditional procurement is reasonable and appropriate.

Under Design build, the risk factors are either shifted to contractor or shared. This research discovered that risk factors under the technical category, namely: 'Errors of original design', 'Insufficient of original design' and 'Complexity of design' are all suggested to be shared. The results are unusual because many studies have concluded that design risks in Design-build procurement typically falls under contractor's responsibility solely. For instance, Shrestha and Fernane (2017) mentioned that in Design-build procurement the client contract with a contractor enables client to transfer the liability and risk of construction design to the contractor.

Respondents might suggest these risks to be shared because in current practice of Design-build projects, the overall duration of the client's design review may be unreasonable and detrimental to design development. Liu et al. (2017) revealed that disputes of review rights frequently emerge between clients and contractors because clients believe that they have the authority to approve the design and contractor can only continue the work when they have received client's approval. Other categories such as resources and construction the suggestion made by respondents are expected where the risk factors are mainly allocated to the contractor. This is in line with statement made by Ogunsanmi (2016) stating that the contractor in Design-build oversees the project's design, procurement, engineering, and construction, and that the client is mainly expected to pay for all these services once the project is completed.

Lastly, it is discovered that risk factors in PPP procurement are mainly shared between the contracting parties. There are four categories where majority of the risk factors are suggested to be shared: economics, environment, social and contractual. Various studies have discovered the mentioned risk categories are better to be shared between contracting parties. For instance, Shrestha et al. (2018) recommended efficient risk allocation for PPP water project and suggested economics, environment, and contractual risks to be shared between government and public.

CONCLUSION

The study has identified that from 38 number of risk factors listed, 12 of them have very high level of occurrence. Thus, construction industry players may take these risk factors into consideration while planning for their risk management. In terms of risk categorization, risk factors under the political category, construction category and contractual category are determined as risks that should be prioritized in risk management. This research studied three type of procurements which are Traditional, Design-build and PPP procurement. It is found that, in Traditional procurement, the risks allocation between contractor and clients are balanced where the risks are allocated based on its nature of work. If the risks are under client's control, then it will be allocated to the client and vice versa. In Design-build procurement, majority of the risk is suggested to be managed by contractor. This is expected as the nature of the procurement itself that creates a single point responsibility to the contractor for the entire project. Compared to Traditional procurement, clients in Design-build procurement are only responsible to a small number of risks. It is found that as the structure of PPP procurement is based on the cooperation between public and private sectors, thus the risks are most likely to be shared between contracting parties. The research succeeds to allocate all of 38 risk factors in Traditional procurement as well as Design-build procurement. However, in PPP procurement the 2 risk factors are undecided, while other 36 risk factors are located to their respective party.

REFERENCES

Abdul Rashid, K., & Khairuddin, S. S. (2017). Preliminaries and Their Prices for Residential Buildins: A Critical Analysis. Malaysian Construction Research Journal (MCRJ), 23(3), 57-69.

Ahmad, U., Ibrahim, Y. B., & Bakar, A. A. (2018). Malaysian Public Private Partnership Projects: Project Success Definition. International Journal of Engineering & Technology, 7(3.30), 33-37.

Almarri, K., Alzahrani, S., & Boussabaine, H. (2019). An evaluation of the impact of risk cost on risk allocation in public private partnership projects. Engineering, Construction and Architectural Management.

Ashmawi, K., Hadidi, L. A., Assaf, S., Tuffaha, F. M., & Al-ofi, K. (2018). Risk assessment and allocation in the contract for public works used in Saudi Arabia construction industry. Cogent Engineering, 5(1).

Burkhauser, S. T., Butler, D., & Kim, Y. W. (2016). The importance of employer accommodation on the job and duration of workers with disabilities: a hazard model approach. Lab. Econ, 3(1), 109–130. 9.

El-Sayegh, S. M., & Mansour, M. H. (2015). Risk assessment and allocation in highway construction projects in the UAE. Journal of Management in Engineering, 31(6).

Hissayat, M. A., Alkasagi, F., El-Mashaleh, M., & Sweis, G. J. (2020). Risk allocation in public construction projects: the case of Jordan. International Journal of Construction Management, 1-11.

Hwang, B. G., & Yu, G. S. (2016). Risk identification and allocation in undergroung rail construction joint ventures: contractor's perspective. Journal of Civil Engineering and Management, 22(6), 758-767.

Ismail, W. W., Isa, S. M., & Yusop, N. Y. (2018). Ideal construction procurement system based on transaction cost approach. International Journal of Academic Research in Business and Social Sciences, 8(1), 807-814.

Jaber, A. Z. (2019). Assessment Risk in Construction Projects in Iraq Using COPRAS-SWARA Combined Method. Journal of Southwest Jiaotong University, 54(4).

Keers, B. B., & Fenema, P. C. (2018). Managing risks in public-private partnership formation projects. International Journal of Project Management, 86(6), 861-875.

Kog, Y. C. (2019). Construction Delays in Indonesia, Malaysia, Thailand, and Vietnam. Practice Periodical on Structural Design and Construction, 24(3).

Lee, Z. P., Rahman, R. A., & Doh, S. I. (2020). Key drivers for adopting design build: A comparative study between project stakeholders. Physics and Chemistry of the Earth, 8.

Lew, Y. L., Hassim, S., Muniandy, R., & Hua, L. T. (2018). Structural equation modelling for subcontracting practice: Malaysia chapter. Engineering, Construction and Architectural Management, 25(7), 835-860.

Liu, J., Xie, Q., Xia, B., & Bridge, A. J. (2017). Impact of design risk on the performance of design-build projects. Journal of Construction Engineering and Management, 143(6).

Loosemore, M., & Cheung, E. (2015). Implementing systems thinking to manage risk in public private partnership projects. International Journal of Project Management, 33(6), 1325-1334.

Mohamed, O., Abd-Karim, S. B., Roslan, N. H., Mohd Danuri, M. S., & Zakaria, N. (2015). Risk management: Looming the modus operandi among construction contractors in Malaysia. International Journal of Construction Management, 15(1), 82-93.

Ogunsanmi, O. E. (2016). Risk classification model for design and build projects. Covenant Journal of Research in the Built Environment, 3(1).

O'shea, C., Palcic, D., & Reeves, E. (2018). Comparing PPP with traditional procurement: The case of schools procurement in Ireland. Annals of Public and Cooperative Economics, 90(2), 245-267.

Park, J., & Kwak, Y. H. (2017). Design-bid-build (DBB) vs. design-build (DB) in the US public transportation projects: The choice and consequences. International Journal of Project Management,, 35(3), 280-295.

Rafaat, R., Osman, H., Georgy, M., & Elsaid, M. (2020). Preferred risk allocation in Egypt's water sector PPPs. International Journal of Construction Management, 1-13.

Rahmani, F., Tayyab, M., & Khalfan, M. (2017). An overview of construction procurement methods in Australia. Engineering, Construction and Architectural Management, 24(4), 593-609.

Richard, J., Luqman, O., & Nurayn, A. (2015). Impact of procurement methods and project types on construction projects performance. Built Environment Journal, 12(2), 50-60.

Salla, D. E. (2020). Comparing Performance Quality of Design-Bid-Build (DBB) and Design-Build (DB) Project Delivery Methods in Nigeria. African Journal of Earth and Environmental Sciences,, 2(2).

Shrestha, A., Chan, T. K., Aibinu, A. A., Chen, C., & Martek, I. (2018, April). Risk Allocation Inefficiencies in Chinese PPP Water Projects. Journal of Construction Engineering and Management, 14(4).

Shrestha, P. P., & Fernane, J. D. (2017). Performance of design-build and design-bid-build projects for public universities. 143(3),. Journal of construction engineering and management,, 123(3).

Siah, W. K. (2020). The Study on the Concept of Traditional Procurement Method and Its Application in Construction Industry in Malaysia. Doctoral dissertation, Tunku Abdul Rahman University College.

Siaw, D. A. (2016). Allocation of risk factors associated with construction contracts in Ghana . Doctoral Dissertation.

Siraj, N. B., & Fayek, A. R. (2019). Risk Identification and Common Risks in Construction: Literature Review and Content Analysis. Journal of Construction Engineering and Management, 145(9).

Violante, A., Dominguez, C., & Paiva, A. (2018). Risk Management in Construction Projects: Are Small Companies Prepared? MOJ Civil Eng. doi:10.15406/mojce. 2018.04. 00090.

Yap, J. B., Goay, P. L., Woon, Y. B., & Skitmore, M. (2020). Revisiting critical delay factors for construction: Analysing projects in Malaysia. Alexandria Engineering Journal, 60(1), 1717-1729.

Zulhafiz, W. M. (2018). Perception of contractual risk allocation in the oil and gas contracts in Malaysia. International Journal of Trade and Global Markets, 11(1-2), 127-137.

SIGNIFICANT FACTORS CONTRIBUTING TO UNAUTHORISED INSTRUCTIONS IN CIVIL ENGINEERING PROJECTS

Wan Norizan Wan Ismail[1] and Hamimah Adnan[2]
[1]Department of Built Environment Studies and Technology, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA Perak Branch, Seri Iskandar, Perak, Malaysia.
[2]Faculty of Architecture, Planning and Surveying, University Teknologi MARA, Shah Alam, Selangor, Malaysia.

Abstract
The aim of this paper was to analyse the significant factors influencing the occurrence of unauthorised instructions in civil engineering projects. A questionnaire with 27 factors identified from literature was sent to the professional civil engineers and G7 contractors registered with their respective umbrella organisations i.e., Board of Engineers Malaysia (BEM) and the Construction Industry Development Board (CIDB). From 288 questionnaire survey returns, this study found that there was a high occurrence of unauthorised instructions in civil engineering projects in Malaysia. The result indicated that poor in complying with the condition of contract, level of understanding condition of contract, ground uncertainty, the familiarity of procurement method used, tight project milestone, clarity of SFoC and project complexity are the most significant factors influencing the occurrence of unauthorised instructions. These seven factors if properly understood and be put more concern by all parties at the onset of every project may smoothen the project implementation and could avoid contractual disputes. Since contracts can be vague about the nature of instructions due to the project complexity and unpredictable ground conditions faced during site implementation, it is highly recommended that all the instructions should be given in writing.

Keywords: *Civil engineering; standard form of contract; unauthorised instruction.*

INTRODUCTION

In civil engineering construction, the engineer issues instructions continually to ensure projects are completed within the specified time, budget and quality. To smoothen the project implementation, the engineer may give instruction to vary the works, remedy the contractor's workmanship, open up work for inspection or test, postpone the works and any works within the authority that is attributed to him under the contract (Zulkifli et al., 2011). These instructions by the engineer or called as 'Engineer Instructions' have to be complied and implemented by the contractor within certain limitations, provided that the instructions are empowered by the contract. Otherwise, the contractor is considered to breach the contract if he disobeys them (Rajoo, 2010).

Nevertheless, because of the civil engineering projects involved with many uncertainties and quite complex in nature, the issuance of instructions that beyond the engineer empowerment under the contract may occur in responding to any issue that arise in the project implementation. For instance, Clause 2.1 under FIDIC Standard Form of Contract (SFoC) provide more empowerment to the engineer in resolving many issues that may arise during project implementation. Lina (1997) stated that the engineer has the authority to expel any unruly labours from a construction site, to conduct the initial protective measure on archaeological discoveries on site and to secure any remedial works necessary for the safety of the works. Nevertheless, this wide-spectrum empowerment given to the engineer could cause disagreement because of the conflict in determining the 'tiny line' between authorised and unauthorised instructions. In the event of unauthorised instructions instructed by the engineer, the contractor does not have the obligation to obey. Otherwise, he will be considered a breach of contract (Chappel et al., 2005). This overwhelmingly cause disputes among the contracting parties if it is not properly managed during the construction process.

The other example of unauthorised instruction that commonly occurs in a construction project is the direct instructions from the client to the contractor without referring or consulting with the engineer. Due to a lack of empirical study on it, the occurrence of direct instructions by the client is not common in civil engineering projects. This might be due to most these kind of projects are the government initiated and are managed by the appointed civil servants on behalf of the government (client) who are well-versed with the contract condition. As stated in the condition of the contract (both PWD and FIDIC), the client has no right to give any order to the contractor. Likewise, this considers unauthorised instructions and the contractor does not have to comply with the orders. The client shall channel his orders through the intermediary of the engineer provided that the orders are within the contract scope. Due to limited empirical study conducted to investigate this issue in civil engineering projects, this study endeavours to investigate the occurrence as well as the significant factors contributing to the unauthorised instructions.

LITERATURE REVIEW

The project characteristics, external factors, attitudes of key participants and quality of SFoC are the four aspects considers in this study to determine the factors contributing to the occurrence of unauthorised instructions. The characteristics of a civil engineering project that full of uncertainty and complexity, combined with the enormous variety of unforeseen situations that can emerge during a construction project, caused disagreements, conflicts, disputes, change orders, and claims can occur in the construction phase (Guo et al., 2016). Other than project characteristics, external factors such as weather condition (Yong & Mustaffa, 2012; Hisham & Yahaya, 2016; Iyer & Jha, 2005) resources availability (Iyer & Jha, 2005; Min et al., 2018; Yu & Shen, 2013) technological advancement (Yang et al., 2012) changes in government regulations and laws (Shehu et al., 2014) and bureaucracy in government agencies (Ahmed & Othman, 2013; Shehu et al., 2014) are found to be other important factors that could influence the occurrence of unauthorised instructions in civil engineering project. Meanwhile, the key participant’s individual attitude factors for example poor in complying with the condition of a contract (Shehu et al., 2014), poor in understanding the content of contract (Shehu et al., 2014), opportunistic behaviour (Alkhamali et al., 2010), cooperation in problems solving, commitment in achieving project goal (Nachatar et al., 2011; Iyer & Jha, 2005) and competency of contractor and engineer (Shehu et al., 2014; Gosling et al., 2013; Ahmed & Othman, 2013) also causes the unauthorised instruction issuance by the engineer and obedience by the contractor. Thus, the attitude of the key participants in carrying out their works in the projects sometimes quite unpredictable and could significantly influence the unauthorised instructions occurrence. In the meantime, many contractual issues highlighted by scholars in literature related to completeness, fairness and clarity of the SFoC (Zhang et al., 2020; Ali & Wilkinson, 2010; Chong & Zin, 2010; Wright & Fergusson, 2009; Zhang et al., 2021). These deficiencies may cause the SFoC to fail to respond to complexity and unpredictable site and ground condition, thus could lead to the occurrence of giving and obey of unauthorised instructions. Therefore, a good contract can shape an adequate level of communication that can ensure the smooth functioning of a project. This is vital since it facilitates a process that allows the parties to achieve good performance.

METHODOLOGY

This study administered 1000 questionnaire surveys to Grade G7 contractors and certified professional engineers. The convenience and snowballing sampling methods were adopted to arrive at the sample size for the study due to low response. These methods were chosen because of the previous authors' experience conducting survey on the same kind of population. As a result, 29% response rate was obtained quickly and economically. In addition, Sambasivan & Soon (2007) and Badi et al. (2021) highlighted that these kind of method are preferred when it is difficult to get response from sample elements selected at random. Therefore, the questionnaires were distributed to friends and relatives who were working in consultant engineer and contractor firms.

The respondents were asked to rate based on a five-point Likert scale the occurrence frequency of unauthorized instructions and the level of influence of the twenty-seven (27) factors in the unauthorized instruction. They were to respond to the survey based on their current and past experience dealing with civil engineering projects. All the collected data from the survey were checked and verified for their correctness. The statistical techniques used to analyse the collected data were Mean score method to determine the rank of the factors that contribute to the occurrence of unauthorised instructions, and Man-Whitney U test to test the significant differences in the important factors considered by the two classes of respondents, i.e engineer and contractor. In literature, indexing by the means of the mean score has been used widely in a variety of research (Shehu & Akintoye, 2010). Therefore, the same method was used in this study for the ranking determination of each variable.

RESULT AND DISCUSSION

Respondent's Demographic

Table 1 shows the background of the survey respondents which 137 engineers (48%) and 151 contractors (52%) responded to the survey. The majority of respondents have extensive experience dealing with civil engineering projects where 46% of contractor respondents and 51% of engineer respondents have more than 10 years working experience. Meanwhile, 49% of engineer respondents and 46% of contractor respondents have working experience between 6 to 10 years.

Table 1. Demographic Background of Respondents

	Contractor		Engineer	
Types of Respondents	**Frequency**	**(%)**	**Frequency**	**(%)**
	151	52	137	48
Experience in civil engineering projects				
Less than 2 years	0	0	0	0
2 to 5 years	12	8	0	0
6 to 10 years	69	45.7	67	49
More than 10 years	70	46.4	70	51
Total	151	100	137	100

The Unauthorised Instructions in Civil Engineering Projects in Malaysia

The respondents were asked to rate the level of occurrence of unauthorised instructions in their current and past projects based on a 5-points Likert scale with the range values from 1 (very low) to 5 (very high) frequent. The decision rule is that any factor whose mean falls between 1.00 – 1.99 is regarded as "low", 2.00 – 2.99 is moderate, 3.00 – 3.99 is high and 4.00 – 5.00 is regarded as very high frequencies.

Table 2. Mean Score of Unauthorised Instruction Occurrence in Civil Engineering Projects

	Overall	Contractor	Engineer	Mann- Whitney U *Sig. p*
	Mean	Mean	Mean	
Unauthorised instruction	3.27	3.36	3.17	0.000*

Based on the mean score of 3.27 (Table 2), it shows that the occurrence of unauthorised instructions in civil engineering projects is at a high level. However, there was a significant difference in the mean score by both group of respondents where the contractor and engineer scored 3.36 and 3.17 mean values respectively. Based on the overall means score, this implied that there was a high occurrence of unauthorised instructions in civil engineering projects. Although the project key participants had the knowledge and awareness that only authorised instructions from an authorised person must be followed this incident still happens. Despite the knowledge that complying with unauthorised instructions is a breach of contract, the occurrence of unauthorised instructions found in this study was high. Therefore, it is critical to investigate the factors causing it to happen. The result and discussion are in the next section.

Significant Factors Contributing to the Occurrence of Unauthorised Instructions

Giving and obeying unauthorised instructions is a serious problem in the construction industry. It could lead to conflict and disputes among project participants. Hence, determining the factors that cause the occurrence of unauthorised instructions is crucial. There were twenty-seven (27) factors contributing to the unauthorised instructions in civil engineering projects assessed using a five-point Likert scale. The range values of the scale were from 1 (very low) to 5 (very high) influence. The factors are considered as having a significant influence if the mean scores are between 4.00 to 5.00 (Shehu et al., 2014; Adedokun et al., 2013; Oyeyipo et al., 2016).

Table 3 present the results of the analysis of the factors that cause unauthorised instructions in civil engineering projects in Malaysia. A total of 27 factors from the four domains (project characteristics, external factors, quality of SFoC, individual attitude of project participants) were ranked according to the ranking of their mean values. Seven (7) of them were found significant in influencing the occurrence of unauthorised instructions with a mean score of more than 4.00. Those factors were poor in complying with the condition of the contract, level of understanding of the condition of the contract, ground uncertainty, the familiarity of procurement method used, tight project milestone, clarity of SFoC and project complexity. Meanwhile there were fourteen (14) factors that give high influence and the remaining six (6) factors have a low influence on the occurrence of unauthorised instructions.

Table 3. The Ranking of Factors that Influenced Unauthorized Instructions

Factors Influencing Unauthorised Instructions	Overall		Engineer		Contractor		Mann-Whitney U *Sig. p*
	Mean	Rank	Mean	Rank	Mean	Rank	
Poor in complying condition of contract	4.27	1	4.22	1	4.31	1	0.088
Level of understanding condition of contract	4.10	2	4.12	2	4.09	3	0.341
Ground uncertainty	4.05	3	4.00	6	4.10	2	0.006*
Familiarity of procurement method used	4.05	4	4.08	3	4.01	7	0.011*
Tight project milestone	4.04	5	4.04	4	4.05	4	0.781
Clarity of SFoC	4.03	6	4.02	5	4.04	6	0.497
Project complexity	4.02	7	3.99	8	4.04	5	0.099
Bureaucracy of government agencies	3.91	8	3.96	10	3.87	9	0.078
Adequacy of details and specifications	3.88	9	3.99	7	3.78	12	0.001*
Changes in government regulations and laws	3.87	10	3.87	12	3.87	8	0.908
Project scope changes	3.87	11	3.96	9	3.79	11	0.000*
Weather condition	3.83	12	3.88	11	3.79	10	0.055
Changes in initial design	3.77	13	3.8	13	3.74	13	0.260
Cooperation in solving problems	3.30	14	3.31	14	3.28	14	0.716
Trust produced by SFoC	3.26	15	3.28	15	3.25	15	0.560
Site access	3.23	16	3.21	18	3.25	16	0.489
Competency of contractor	3.22	17	3.21	17	3.23	17	0.763
Resources availability	3.16	18	3.26	16	3.07	20	0.000*
Project size	3.15	19	3.14	20	3.16	18	0.727
Surrounding uncertainty	3.14	20	3.12	21	3.15	19	0.458
Completeness of SFoC	3.05	21	3.17	19	2.93	21	0.000*
Technological advancement	2.85	22	2.99	22	2.72	23	0.000*
Multicultural team	2.77	23	2.74	24	2.79	22	0.250
Fairness of SFoC	2.66	24	2.9	23	2.45	24	0.000*
Procurement method	2.53	25	2.66	25	2.42	26	0.000*
Project type	2.43	26	2.44	27	2.43	25	0.022*
Type of SFoC	2.33	27	2.45	26	2.22	27	0.000*

Poor in Complying Condition of Contract

With a mean score of 4.27, this factor was ranked as the highest factor causing the occurrence of unauthorised instruction. The failure to refer and comply with the condition of the contract while issuing instructions to the contractor may cause the engineer to give orders beyond his empowerment. This incident may cause the contractor not to be entitled for payment or extension of time (EOT) claim under the contract if he complies with the instructions. As an agent to the client, the engineer is enabled to make certain decisions and issuing instructions. With huge responsibilities and obligations, the engineer role in the contract depends on his independence in making decisions. As a safeguard, the contractor can challenge the validity of the instructions by seeking further clarification from the engineer if he finds they were beyond the contract scope. Therefore, it is vital for the project key participants to comply with the condition of the contract to avoid the act of giving and obeying unauthorised instructions from occurring.

Level of Understanding of the Condition of Contract

The lack of understanding of the contract condition was the second significant factor leading to poor contract management that may in turn, result in failure to comply with the contract document. Eventually, the failure to comply with the contract by project participants resulted in the occurrence of unauthorized instructions. Due to many types of SFoC available in the construction industry, (Rajoo, 2010) stated that the project key participants must be familiar with the particular SFoC used. This understanding and familiarity also come from experiences in handling various contracts in a construction project. The lack of understanding of the SFoC and giving too much trust and responsibility to the engineer to pursue his obligation under the contract could introduce the unauthorised instructions. Therefore, being well-versed on the particular SFoC used for a project by all participants is essential to reduce the occurrence of unauthorised instructions.

Ground Uncertainty

The third significant factor was the ground uncertainty with a 4.05 mean score where the ground condition as well as the problems related to the site surroundings are unpredictable in civil engineering projects. Nevertheless, there was a significant difference in the mean values score by both types of respondents where the engineer and contractor scored 4.00 and 4.10 mean value respectively. The unpredictable ground condition makes the greater the risk to the construction process, which sometimes can be quite a challenge for the engineer to respond to it (Ismail & Adnan, 2020; and Ismail et al., 2019). Due to this issue, perhaps some pressing instructions must be issued especially when associated with the safety of labours or the people surrounding the site. Unfortunately, due to the urgency in giving and obeying the instructions, sometimes the instructions given are beyond the engineer empowerment in the project.

Familiarity of Procurement Method Used

The overall mean score was 4.05 making this factor was the fourth significant factor contributing to unauthorised instructions. However, there was a significant difference in the mean score rated by both types of respondents. The knowledge and familiarity about the type of procurement method used for the particular project they are handling are very critical to be possessed by all project participants. This is because a different type of procurement method has a different structure with different roles, responsibilities as well as authorities of each project participant. The attitude of being too attached to the traditional method, reluctant to explore and familiarise themselves with other types of procurement systems may lead to confusion on the roles and responsibilities of project participants. Due to the many types and variances of procurement systems in the industry, the probability of confusion about the structure and authority for different procurement methods could occur which eventually may lead to unauthorized instructions and communication problems (Ismail & Adnan, 2020).

Tight Project Milestones

The fifth significant factors contributing to the occurrence of unauthorised instruction was the thight project milestone. According to Ismail et al. (2019), high commitment and efficient communication among the project participants are very crucial when the construction project involves tight project milestones. The distribution of information and instruction from all levels of management must be done in appropriate and effective ways. In the struggle of meeting the tight schedule, some of the instructions issued by the engineer might be beyond empowerment. Besides focusing on resuming the construction works, the engineer also considers other aspects such as safety during the construction in progress. In addition, lack of adequate resources and inappropriate procurement methods used for this kind of project may also cause the problem to be more severe . As a result, the engineer's instruction might cross his border of authority and lead to the issuance of unauthorised instruction to respond to the emergency situation.

Clarity of SFoC

The quality of SFoC used for the project especially in the aspect of clarity also give significant influence on the occurrence of unauthorised instructions in civil engineering projects. According to Ismail et al. (2019) the difficulty in understanding the condition of the contract might be due to the factors of high-level contractual language and its judicial interpretation. This very often leads to contractual obligations misunderstanding which eventually could cause the issuance of unauthorised instructions. As replete in the literature, among the factors that cause confusion to the contracting parties about the condition of the contract are the existence of multiple cross-references with clauses and long sentences in the contract (Zhang et al., 2020; Ali & Wilkinson, 2010; Chong & Zin, 2010). Since the function of SFoC is to provide administrative procedures in the construction work and to regulate the legal relationship between contracting parties, clear and unambiguous SFoC clauses is vital.

Project Complexity

Civil engineering projects are projects full of uncertainty and complexity in terms of the stakeholders involved, procedures, design and construction techniques. Thus, most of the time require a complex and scrupulous construction method to suit the unpredictable challenging ground condition. Based on the result of this study, it was revealed that the level of complexity of civil engineering projects give a very significant influence on the occurrence of unauthorised instruction with a mean score of 4.02. Besides the complexity of the construction design and method, the project with the involvements of various stakeholders also makes it complex to manage and has a higher possibility of increasing the occurrence of unauthorised instructions. The approach of managing a complex project such as civil engineering project must take into account the organizational aspects such as in the allocation of tasks and sharing of the responsibility for decision-making. In addition, the technological aspects in terms of knowledge transfer as well as materials or equipment and arrangement of activities may increase the complexity and contribute to the giving and obeying unauthorised instruction issues.

CONCLUSION

It was found that the occurrence of unauthorised instruction is at a high level in Malaysian civil engineering projects. Only seven factors were found significant in causing the unauthorised instructions. They were three factors under the project characteristics domain (ground uncertainty, tight project milestone, project complexity), three factors under the attitude of the key participant domain (poor in complying with the condition of contract, level of understanding of the condition of contract, familiarity with the procurement method used) and one factor under the quality of SFoC domain (clarity of SFoC). It provides evidence that the key participant's individual attitude during project implementation sometimes may be unpredictable and highly causes the unauthorised instruction issuance by the engineer and obedience by the contractor. Besides, the characteristics of a civil engineering project that is full of uncertainty and complexity, combined with the enormous variety of unforeseen situations that can emerge during a construction project, caused disagreements, conflicts and change orders can occur in the construction phase, thus causing the occurrence of unauthorised instruction. The contractual issues mainly related to the clarity of the SFoC may cause the SFoC to fail to respond to complexity and unpredictable site and ground conditions thus could lead to the occurrence of giving and obey of unauthorised instructions. In addition, contracts can be vague about the nature of instructions due to the project complexity and unpredictable ground conditions faced during site implementation. Thus, all the instructions should be given in writing. Disagreement about the validity of instruction may result in a dispute being deemed to have arisen, which eventually could lead to project problems. Hence these seven significant factors must be well understood and put serious attention by all project participants in reducing the severity of unauthorised instructions occurrence in civil engineering projects in Malaysia.

REFERENCES

Adedokun, O. a., Ibironke, O. T., & Babatunde, S. O. (2013). Assessment of competitive tendering methods of procuring educational building projects in Nigeria. *Journal of Facilities Management*, *11*(1), 81–94. https://doi.org/10.1108/14725961311301484.

Ahmed, A., & Othman, E. (2013). Challenges of mega construction projects in developing countries. *Organization, Technology and Management in Construction*, *5*(1), 730–746. https://doi.org/10.5592/otmcj.2013.1.10.

Ali, N. A. N. A., & Wilkinson, S. (2010). Modernising construction contract drafting – A plea for good sense. *Proceedings of the 18th CIB World Building Congress*, 323–345.

Alkhamali, K. S., Motawa, I., & Ogunlana, S. (2010). Cultural Factors Influencing Disputes in Public Construction. In *Proceedings of the 18th CIB 2010 World Building Congress* (pp. 475–488).

Badi, S., Ochieng, E., Nasaj, M., & Papadaki, M. (2021). Technological, organisational and environmental determinants of smart contracts adoption: UK construction sector viewpoint. *Construction Management and Economics*, *39*(1), 36–54. https://doi.org/10.1080/01446193.2020.1819549.

Chong, H. Y., & Zin, R. M. (2010). A case study into the language structure of construction standard form in Malaysia. *International Journal of Project Management*, *28*(6), 601–608. https://doi.org/10.1016/j.ijproman.2009.09.008.

Gosling, J., Naim, M., & Towill, D. (2013). Identifying and Categorizing the Sources of Uncertainty in Construction Supply Chains. *Journal of Construction Engineering and Management*, *139*(1), 102–110. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000574

Guo, L., Li, H., Li, P., & Zhang, C. (2016). Transaction costs in construction projects under uncertainty. *Kybernetes*, *45*(6), 866–883. https://doi.org/10.1108/K-10-2014-0206.

Hisham, S. N. A., & Yahaya, K. (2016). Causes and effects of delays in Malaysian construction industry. *International Journal of Project Management*, *25*(5), 517–526.

Ismail, W. N. W., Adnan, H., Baharuddin, H. E. A., Ismail, N. A. A., & Yaman, R. (2019). Contractual Behaviour in Civil Engineering Projects: Delay of Contractors Work Progress. *Malaysian Construction Research Journal*, *10*(2), 200–213.

Ismail, W. N. W, & Adnan, H. (2020). The Influence of Project Characteristics on Contractual Behaviour of Key Participants in Civil Engineering Projects. Built Environment Journal, 17(2), 75. https://doi.org/10.24191/bej.v17i2.9030.

Ismail, W. N. W, Adnan, H., & Khalil, N. (2019). Factors influencing civil engineering project performance. Journal of Building Performance, 10(2), 11–20.

Iyer, K. C., & Jha, K. N. (2005). Factors affecting cost performance: Evidence from Indian construction projects. *International Journal of Project Management*, *23*(4), 283–295. https://doi.org/10.1016/j.ijproman.2004.10.003.

Lina, C. (1997). Role of engineer under FIDIC form contract. *Journal of Professional Issues in Engineering Education and Practice*, *123*(April), 48–50. https://doi.org/10.1061/(ASCE)1052-3928(1997)123:2(48).

Min, J. H., Jang, W., Han, S. H., Kim, D., & Kwak, Y. H. (2018). How Conflict Occurs and What Causes Conflict: Conflict Analysis Framework for Public Infrastructure Projects. *Journal of Management in Engineering*, *34*(4), 4018019. https://doi.org/10.1061/(asce)me.1943-5479.0000625.

Nachatar, J. S., Hussin, A. A., & Omran, A. (2011). Frustration of Contract in the Malaysian. *International Journal of Engineering*, *3*, 85–90.

Oyeyipo, O. O., Odusami, K. T., Ojelabi, R. A., & Afolabi, A. O. (2016). Factors affecting contractors' bidding decisions for construction projects in Nigeria. *Journal of Construction in Developing Countries*, *21*(2), 21–35. https://doi.org/10.21315/jcdc2016.21.2.2.

Rajoo, S. (2010). The PAM 2006 Standard For of Building Contract- a change in risk allocation,. *Malaysian Law Journal*, *10*(4), cxlvii.

Shehu, Z., & Akintoye, A. (2010). Major challenges to the successful implementation and practice of programme management in the construction environment: A critical analysis. *International Journal of Project Management*, *28*(1), 25–39.

Shehu, Z., Endut, I. R., & Akintoye, A. (2014). Factors contributing to project time and hence cost overrun in the Malaysian construction industry. *Journal of Financial Management of Property and Construction*, *19*(1), 55–75. https://doi.org/10.1108/JFMPC-04-2013-0009.

Wright, J. N., & Fergusson, W. (2009). Benefits of the NEC ECC form of contract: A New Zealand case study. *International Journal of Project Management*, *27*(3), 243–249. https://doi.org/10.1016/j.ijproman.2008.03.005.

Yang, L. R., Chen, J. H., & Wang, H. W. (2012). Assessing impacts of information technology on project success through knowledge management practice. *Automation in Construction*, *22*, 182–191. https://doi.org/10.1016/j.autcon.2011.06.016.

Yong, Y. C., & Mustaffa, N. E. (2012). Analysis of factors critical to construction project success in Malaysia. *Engineering Construction and Architectural Management*, *19*(5), 543–556. https://doi.org/10.1108/09699981211259612.

Yu, A. T. W., & Shen, G. Q. P. (2013). Problems and solutions of requirements management for construction projects under the traditional procurement systems. *Facilities*, *31*(5/6), 223–237. https://doi.org/10.1108/02632771311307098.

Zhang, L., Fu, Y., & Lu, W. (2021). Contract Enforcement for Claimants' Satisfaction with Construction Dispute Resolution: Moderating Role of Shadow of the Future, Fairness Perception, and Trust. *Journal of Construction Engineering and Management*, *147*(2), 4020168. https://doi.org/10.1061/(asce)co.1943-7862.0001981.

Zulkifli, U. K. Z. @, Zakaria, N., Salleh, H., Ali, A. S., & Yeah, C. L. (2011). the Comparative Study of International Standard Form of Building Contract (Fidic Conditions of Contracts for Construction - the New Red Book 1999) and Malaysian'S Standard Form of Building Contract (Pwd 203a). *International Engineering Education Conference 2011*, (December), 8.

FLOOD RISK MANAGEMENT IN XAY DISTRICT, LAO PEOPLE'S DEMOCRATIC REPUBLIC REQUIRES STRENGTHENING

Souksamay Manhmanyvong[1], Suwattana Thadaniti[1], Rostam Yaman[2] and Muhammad Azwan Sulaiman[2]
[1]*Environment, Development & Sustainability Program, Graduate School, Chulalongkorn University, Thailand.*
[2]*Faculty of Architecture, Planning & Surveying, Universiti Teknologi MARA, Malaysia.*

Abstract
The purpose of this paper is to evaluate and strengthen the local government's (LG) practise of own resilience and flood risk management (ORFRM) in Xay District, Lao People's Democratic Republic, which is prone to regular flooding. Four methods are used to collect data: desk research, direct observation in the field with a participatory and non-participatory approach, semi-structured interviews with two groups of respondents (25 individual respondents and 14 expert respondents) from the public and the people and focus group discussions. The examination of secondary and primary data reveals that the LG of Xay District implements 18 of the 26 ORFRM factors, accounting for 69.23 percent of the total. However, the district is lacking eight components, which account for 30.77 percent of the variance. The LG has four strong factors (15.39 percent), ten moderate factors (38.46 percent), and twelve weak factors (46.15 percent). Additionally, the outcome pertains to the conditions in upstream, midstream, and downstream locations, as well as LG practises prior to, during, and following significant rains. Thus, the LG should develop specialised regulations, structural methods and non-structural approaches. These projects may contribute to the development of ORFRM's paradigm for long-term sustainability of LG practises. This study can supplement and update existing theories to urge residents along major rivers and other stakeholders to contribute to the development and execution of long-term strategies in the Xay District.

Keywords: *Flood risk; local government; strength; management plans; resilience.*

INTRODUCTION

Flooding is a dangerous phenomenon that occurs regularly in many nations due to excessive rainfall, natural stream blockages, topography, deforestation, urban management, and other natural phenomena (Oubennaceur et al., 2019; UNISDR, 2015). In India, a deficits of the local administration in flood risk management and readiness are the lack of a distinct organisation that implements legislation (Dash & Punia, 2019). Management of flood risks is mange the potential loss that may arise from floods (Tariq, Farooq & Giesen, 2020). Flooding has put the Lao People's Democratic Republic (Lao, PDR) at risk of casualties, deaths, and socioeconomic losses. Typhoon Jebi in 2013, for example, produced floods in several areas (Thanthathep et al., 2016). Many locations in Lao PDR are extremely vulnerable to flooding. Figure 1 depicts the location of Xay District. Mountains, rivers, and tributaries which cover around 80% of the entire geographic area. The district receives 1,400–1,600 mm of rain each year on average. When it comes to flooding, however, it has limited coping capabilities. As a result, floods are always a threat, with the most recent major storm in August 2017 resulting in 15 deaths and $400,000 in property damage (Xay District Disaster Prevention and Control Committee, 2019).

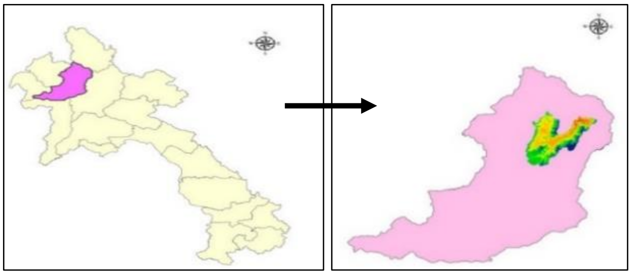


Figure 1. Xay District's Location Map

This paper conducts the local government procedures takes these weaknesses into account and aims to two objectives:

1. To assess the current Local Government practice for flood risk management of the Xay District.
2. To strengthen the policy of the Local Government practice of Own Resilience and Flood Risk Management (ORFRM), which affects the sustainable development of this district.

REVIEW OF RELATED LITERATURE

In Lao PDR. Floods were most frequent occurrences during the monsoon season from May to October (UNDP, 2018). Flooding is likely to occur when more than 200 mm of rain falls in less than two days. According to United Nations Office for Disaster Risk Reduction, some flooding reports were induced by storms and harsh weather associated with flash floods were still a threat (UNISDR, 2012). The smarter way you manage the risk, the lower of risk that you will face (Ibrahim & Esa, 2019). In Lao PDR was the disaster law since 2019 (Law on Disaster Risk Management in Lao PDR, 2019) to consider for one flood risk management from all disaster. The Local Government of Xay District follows a different flood management act for steering than the district's revolutionary party (United Nations, 2005), and the public administration side is led by a governor who has full power and the authority to implement partnerships with other offices. The District Disaster Prevention and Control Committee (DDPCC) is a non-resident office that distributes disaster tasks, such as flooding difficulties caused by man-made and natural disasters. The DDPCC is in charge of emergency response, humanitarian aid, and flood mitigation (Centre for Excellence in Disaster Management and Humanitarian Assistance, 2017). On the other hand, the Xay District's flood risk management has long been hampered by a lack of human resources, finance, and equipment. The Sendai Framework has tried to address these issues. This non-binding agreement recognises the government's primary role in reducing flood risk. For example, recognising and strengthening flood risk management, assessing post-flood scenarios, and applying the 'Build Back Better' idea for recovery (UNISDR, 2015). Additionally, it aided in the formulation of a financial strategy. High priority has been given for establishing early warning and information dissemination system in 142 districts in Lao PDR by 2010 was indicated as a priority (UNDRR, 2019).

Resilience

The origin of the concept of resilience by Holling (1973) applied the concept to the social-ecological system. The resilience idea had evolved, changing from the past to the present (Table 1).

Table 1. Definition of Resilience from The Past to Present

Authors	Definition of Resilience
(Holling, 1973) (p.14–17)	Persistence of systems and their ability to absorb change and disturbance
Organizations	**Definition of Resilience**
(Intergovernmental Panel on Climate Change [IPCC], 2007)	The ability of the social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation and the capacity to adapt to stress and change
(United Nations International Strategy for Disaster Reduction [UNISDR], 2010)	The ability of a system, community or society exposed to hazard to resist, absorb and accommodate to recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structure and functions
(UNISDR, 2015)	'Build back better' concept

Table 2. Applications of the Resilience Concept

Field	Core Concepts	Applications
Human development	Individual resilience, human well-being and capacity agency	Coping and thriving in times of adversity, individual responses to crises and poverty traps
Planning	Urban resilience	Urban and regional planning for resilience
Disasters and disaster risk reduction (including floods)	The vulnerability of community resilience	Minimizing risk, supporting quick recovery and building back better

(Source: Brown, 2013)

For cities, establishing urban resilience was critical (Govindarajulu, 2020). Thus, this paper concentrated on the ORFRM for the Xay District. But it cannot be successful without enabling societies to be resilient to floods and future development does not increase vulnerability, as appropriate, to be integrated into policies, plans, and budgets at all levels. To adequate, timely and predictable resources for risk reduction in order to enhance the resilience of cities (United Nations, 2012). It seeks to mitigate the future harm and seize the opportunity to improve the risk management. Applications of the resilience concept (Brown, 2013; UNISDR, 2015) to minimizing flood risks, quick response, recovery, and build back better after floods in District. The ORFRM concept was suitable for the Xay District. It can help to improve many factors that may plan for in the next events of the District.

METHODS

Data Collection

Data were collected using four methods: desk research (Sarker et al., 2020), direct observation in the field (Williams et al., 2020), semi-structured interviews (Walkling & Haworth, 2020) and focus group discussion (Williams et al., 2020).

Table 3. Summary of Data Collection

Data Collection Techniques	Types of Collected Data	Sources of Data
1. Desk research	- Flood management plan and strategy	- The data from disaster relief, welfare and national disaster management committee and Xay's disaster management office (2019)
	- Daily record including the maximum, mean and minimum rainfall	- The quality-controlled data set from the Department of Meteorology and Hydrology in Lao PDR and Xay's meteorological and hydrological station (2019)
	- Urban plan and land use plan, including local governmental plan and human activities	- Assessment of urban and land-use planning, increasing local and housing approval from the Office of Public Works and Transport in the Xay District (2019)
	- Geographical characteristics in Xay District	- Geographical characteristics of the district, main and tributary rivers from Xay District's interior office (Terrain map) and Google Earth Map (2019)
	- Deforestation and forestry management in the Xay District	- Assessment of the deforestation of locals' activities (Xay District's agricultural and forestry office) (2019)
2. Direct observation in the field with non-participatory and participatory approaches	- Physical existing problems, such as destruction after flood problems of heavy rainfall, human activities for recovery practice and future prevention	- Observation in Xay District and sample-specific villages ([Kor Noy] Up, [Thin] Mid and [LongKordeua] Downstream villages)
3. Semi-structured interviews with 25 individual interviewees and 14 expert interviewees	- Risks of local people, flood risk management, flood impact, urban plan, land use plan and geographical characteristics on flood prevention practice - Development of strengthening for flood risk prevention and management	- Interview of both groups of respondents on factors affecting their management for resilience to floods, following the concept of this study
4. One focus group discussion organised on 21 February 2020 with 43 total participants (15 females)	- Open questions to share their opinion and previous flood risks-impact experiences in Xay District - Development of strengthening for flood risk prevention and management	- Discussion from groups (e.g., LG, locals and experts) of respondents and those who have interest, experience and knowledge on helping flood risk management activities

A purposiveness sampling technique was used to choose a specific group of respondents (Creswell, 2007). The target group included persons who work in and are accountable for the LG's flood management efforts in Xay District. A survey using semi-structured questions was conducted with 25 individuals and 14 experts to represent two distinct groups, the public and the people. All respondents were chosen are the head and deputy head of relevant organisations from a limited population and through a process of deliberate selection. The effect on the proportion of confidence was 100 percent. The data visualisation were organised according to comparative differences. The similarities between the respondents' justifications were categorised into themes. The gathered data on flood risk management were analysed in order to extract data from ORFRM and a qualitative method was used (Forman et al., 2008). Throughout the interview, a voice recording instrument was used. After that, the recording was translated from Lao to English. A conclusion included elements which had a higher proportions of the field data collection and interview. The draft of the outcomes were prepared for a focus group discussion that were organised in order to get a large number of respondents. The researcher explained the draft of the outcome and enquire open-ended questions on ORFRM operations to the respondents. This strategy was implemented as it is likely to produce the best results in Xay District.

Data Analysis

Table 4. Summary of Methods of the Data Analysis

Items	Data Analysis	Methods				Expect Result
		1. Desk Research	2. Direct Observation in the Field	3. Interview	4. Focus Group Discussion	
Assessment of the current LG practice for flood risk management						
LG practice	Analysis of compared differences, the phenomenon of physical existing problems, future prevention and similarities and description of results	✓	✓	✓	✓	Answer the first objective
Local people participation		✓	✓	✓	✓	
Human resources		✓		✓	✓	
Budget		✓		✓	✓	
Technology		✓	✓	✓	✓	
Others		✓	✓	✓	✓	
Own resilient and flood risk management analysis						
Non-structure methods	Analysis of comparison differences, the phenomenon of physical existing problems and future prevention and similarities. After that the description results.	✓	✓	✓	✓	Answer the second objective
Structure methods		✓	✓	✓	✓	
Pre-period of readiness		✓	✓	✓	✓	
Amid period of mitigation		✓	✓	✓	✓	
Post period of building back better		✓	✓	✓	✓	
Strengthening of own resilient flood risk management of LG	Summary of the input and output description from the research questions; recommendation results and discussion	✓	✓	✓	✓	Answer the second objective

The data analysis was two types of data sources.

1. The secondary data analysis of varies documents from desk research were investigated. The varied resources include literature reviews, books from external and internal sources in Lao PDR, various reports of Xay District, the Internet, newspapers and other medias. This help researchers understand the background of the flood risk management of the Local Governments, previous impacts, risk attitudes, and urban planning practices, as well as understand relevant issues in District.

2. The primary data analysis of the information on flood management in Xay District were collected from January 2019 to March 2020. Researcher focus on the direct observation in the field for 14 months by carried out on March 2020 with everyday emphasis for the field research and interview repeatedly related flood risk activities were divided into the follow:

Step 1: To obtain the preliminary data analysis of investigation during the fieldwork by using direct observation in the field, non-participatory and participatory approaches were used to understand the local's interaction and familiarity with Local Government's practices. The components that were used to guide the direct observation in the Xay District, three sample villages (up, mid, downstream). They started after the desk research and revise the semi-structured questions many times before go to the field visit, then use the questions tested with some key person and non-key person in the District to try to understand the field conditions. After that revises again to fit the semi-structured questions, focus many questions respectively, especially, emphasize the 26 ORFRM factors for current situations for direct observation in the field during 14 months, how to strength ORFRM in the next step. Moreover, the researcher saw how much the stakeholders interacted and were involved in the District. The researcher visited and took photos to explore flood risk management activities.

Step 2: After the preliminary data analysis, a qualitative method on ORFRM was used to cover the objectives of this paper. The interview with individuals and experts used semi-structured questions regarding specific key performances. The information about individual interviewees is discussed and analysed. Twenty-five individual respondents of the Local Government and the local peoples who have previous flood experience and have roles in dealing with several flood management tasks in up, mid and down-stream villages in Xay District. The objectives were to analyse flood risk, the current practice of the Local Government in dealing with strong and weak factors and ways to strengthen them through ORFRM in the district and villages. The average age of participants is 52 years old; thus, they have more experiences and ideas to share from the past impact and many visions that can help the policy to solve the risks. All respondents have lived in Xay district for an average of 35.08 years; thus, they know District situation very well and able to engage in elaborated discussion. The yearly average for the current position of respondents at work was 10.04 years; thus, they must have the right, the responsibility and roles that are relevant in ORFRM. Moreover, expert interviewees from the national and provincial government, academicians, international organizations, and national consultancy officers have the roles that deal with risk management with several floods at different levels. Opinion data analysis was used to explore the perspective of strengthening for flood prevention and ORFRM in Local Government's practices in District or other good practices from other sources that may guide Xay District's adaptation.

Step 3: Comments from all 25 individual respondents are inputted into MS Excel to yield the research findings based on 26 ORFRM factors. The conclusion provides a narrative interpretation of the data. The data display was categorised in terms of comparison differences, the phenomenon of physical existing problems, human activities for recovery practice, future prevention and similarities of reasons manifesting through informants. The data were synthesized and described according to the data analysis of this study.

Step 4: Furthermore, the study also organised one focus group discussion meeting held on 21 February 2020 with 43 total participants (15 female). In the meeting, the researcher reported the information on summaries and data analysis from the four methods with participants that mainly including the governor and vice governors of the district, leaders of the district's office line. The researcher wanted to obtain the opinion of the locals, village leaders located in up-, mid- and downstream areas of rivers and some business groups and NGOs to visualise and understand objectives. Open-ended questions related to ORFRM activities were answered by respondents in the discussion. The best methods that are sensible for Xay District were obtained. Most of the participants (95%) agreed with the data analysis report. Only a few respondents suggested improvement some points.

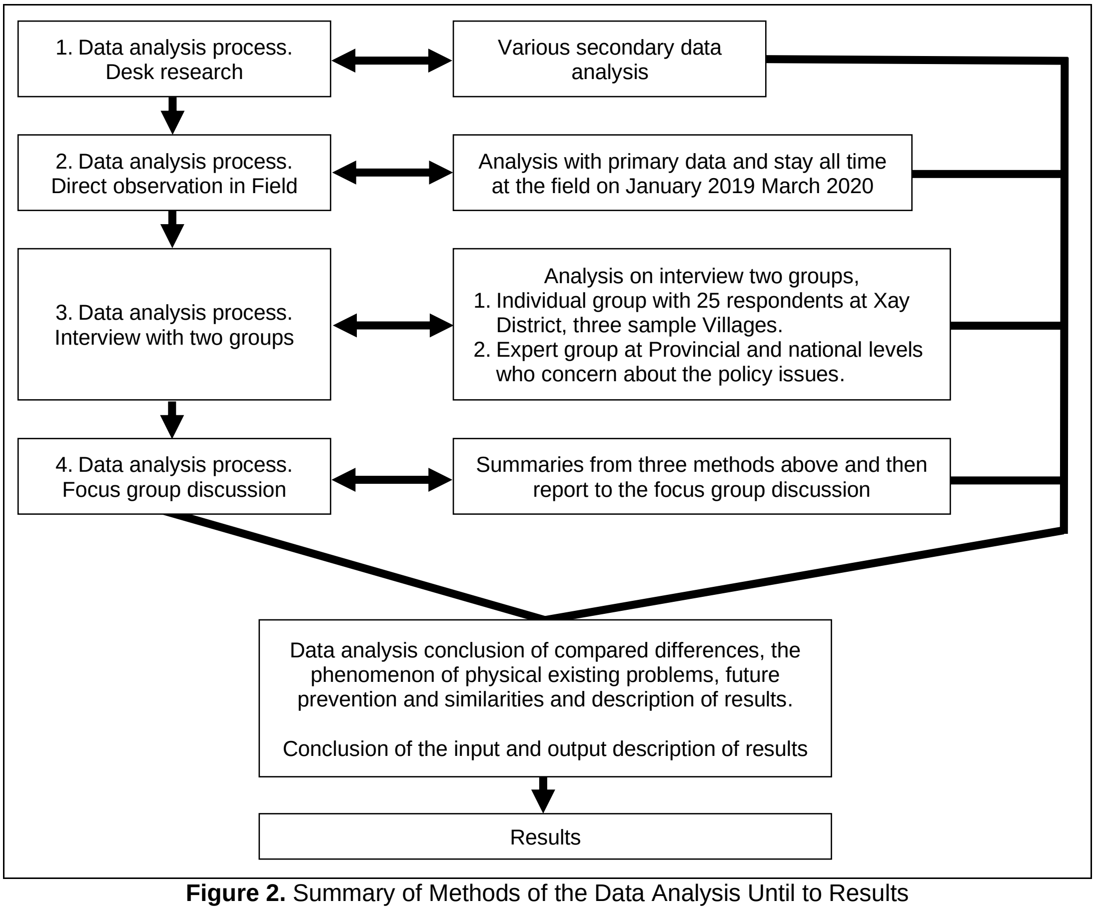


Figure 2. Summary of Methods of the Data Analysis Until to Results

Therefore, conclusions from meeting and the data analysis in the result section are shown in Table 5.

RESULTS

They proved based on four methods when key stakeholders come to focus group discussion, most of the participants agreed to 95 % at that meeting. When reflecting the phenomenon of physical existing and direct observation, analysis in the field can be confirmed with the deck research link interview output of the sample respondents.

Natural Flood Characteristics

The district was prone to flash floods because of the confluence of three main rivers, namely, Kor, Hin and Mao, which are located upstream in the high mountains surrounding the low-lying urban areas. Thus, after heavy rainfall, rainwater from the top of the mountains flow into urban areas, resulting in flash floods within 4–6 hours. The flood was the stock period between 2-3 days effects in the urban and was slowly discharged to downstream.

Upstream, Midstream and Downstream Areas in Xay District

The result with four method analysis can show the upstream area is located in a high mountain surrounded by canals. Approximately 56% of the locals are farmers who cut trees and cleared the land to cultivate vegetation along the Kor River. Midstream and downstream areas along the riverbank were highly populated areas near the district's centre and market. The illegal settlement was a concern because it led to flood risks along the riverbank and two tributaries (Mao and Hin Rivers), flowing down into the Kor River. Furthermore, the Kor River meander has am inefficient discharge capacity.

Assessing Local Government Practices

A total of 26 factors for ORFRM from literature research and test in the Xay District prior were identified and assessed. The Local Government practices 18 out of 26 factors, accounting for 69.23% of the factors, and the remaining 8 factors are unavailable, accounting for 30.77%. The Local Government has 4 strong factors (15.39%), 10 moderate factors (38.46%) and 12 weak factors (46.15%). Local Government is just do the relief action for first, after that damage assessment, and post demand assessment. Such as examples.

The sixth factor of rainfall and meteorological pattern assessment is on behalf of explained the availability and strength factor (in Table 5). Monitoring this factor is important for supply rainfall data, and meteorological pattern assessment of flood predicts calculation. Since 2018, the Local Government has set up and improved the system of Xay's hydrological and meteorological station located in Donkeo village under district. This station manages received signals, an early warning system. Before every wet season, letters are sent to village committees about the need to prepare for flooding. The Office of Natural Resources and Environment (OoNRE) at the district level is responsible for early warning information. Thus, they currently broadcast the weather situation through district radio every day. Information on upcoming storms that led to heavy rain and floods is sent from the Department of Meteorology and Hydrology in the Vientiane Capital under the Ministry of Natural Resources and Environment (Central Government sends to Local Government) to the Department of Natural Resources and Environment in the province and OoNRE in the Xay District (respectively). OoNRE then sends notifications to the district, which forwards them to the villages by fax, phone and official letters. The village committees and schools set up information meetings when river levels rise to initial flood readiness by safeguarding assets and preparing for evacuation if required. At the beginning of a flood event, the DDPCC calls villages and relevant agencies. Village committees then inform local villagers by loudspeaker systems, and volunteers walk around to inform households in remote areas of the village that are far away from the loudspeakers.

The first factor of legislation, law and policy is on behalf of explained the availability and moderation factor (in Table 5), has a new law on disaster management at the national level. Legislations relevant to flood risks, such as the urban plan law, national road law, land law and water resources law were already available, but they do not specifically focus on flood risk management. These regulations emphasised strategy, vision and planning overview. The Local Government in Xay District required elaborate research and attempted to promote the local community for participation with many choices. District had water usage management regulations in the irrigation sector but needed to develop flood risk prevention in detail.

The second factor of human development is on behalf of explained the availability and weakness factor (in Table 5). The Local Government in District had human resource development plans to improve many factors about technical work for flood risk management. Knowledge of modern technologies was used for plans. Preparation was made before the rainy season arrives using flood risk indicators. Flow amount measurement was difficult to calculate, preparing response plans challenging.

Table 5. Results of Factors of the ORFRM from Data Analysis

No.	Items	Availability		Factors' Strength		
1	Law, legislation, policy and regulation	Yes			M	
2	Human resources development	Yes				W
3	Budget allocation	Yes			M	
4	Equipment and technology preparedness (such as rescue resources)		None			W
5	Rescue vehicles (such as boats, helicopters and trucks)		None			W
6	Meteorological and rainfall assessment	Yes		S		
7	Geographical characteristic assessment	Yes			M	
8	Deforestation assessment	Yes			M	
9	Urban planning assessment	Yes				W
10	Local population control	Yes			M	
11	Land-use change assessment	Yes				W
12	Experience and previous risk assessment	Yes				W
13	Time assessment (before, during and after) and immediate flood prevention, rescue and recovery		None			W
14	Early warning systems and prediction equipment (such as signs, signals and networks)	Yes		S		
15	Flood awareness, education and dissemination (using television, radio, newspaper and social media)	Yes			M	
16	Flood data collection and analysis	Yes			M	
17	Flood map documents and map analysis		None			W
18	Infrastructure monitoring and maintenance (dike and bank erosion protection and road safety)	Yes				W
19	Cleaning programmes for canals and drainage systems		None			W
20	Pumping stations and mobile pumping		None			W
21	Flood zones, plains and flood bypass		None			W
22	Evacuation procedures and surveying of evacuation routes		None		M	
23	Storing food and drinking water	Yes			M	
24	Flood shelter	Yes		S		
25	Establishment of various rescue teams and other teams	Yes		S		
26	Overall risk regular inspection and measurement	Yes			M	
	Total	18	8	4	10	12

Note: S = strong, M = moderate and W = weak

The fourth factor of equipment and technology is on behalf of explained the non-availability and weakness factor (in Table 5). The Local Government only had relief equipment for preparing rescue resources which belonged to specific units in the district. District uses a list of disaster rescue tools in emergencies, such as the first aid tools and ambulance vehicles from hospitals and fire trucks from the police headquarters. It may call for help with and deployment of physical tools, money and human resources. Resuscitation devices do not have a specific use during flood situations in Xay District. They are kept in Oudomxay's provincial hospital and cannot be moved from the hospital to the field. Therefore, they cannot be used with flood victims when they are needed. Other factors are shown in Table 5.

Only 4 strength factors from all 26 factors, which mean the 22 factors might to the strengthening of ORFRM in the Xay district.

Local Government Practices Dealing with Foods (Before, During and After)

Before flooding. The early warning system is set off to inform the locals of the possible occurrence of a flood. The Local Government is aware that most flood occurrences are caused by rainfall. All stakeholders prepare before the rainy season using the calendar. They follow three levels of attention: low-, moderate- and high-risk levels. For example, June to October of every year requires high readiness for flood risk management.

Table 6. Flood Risk Levels Per Month

Risk	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flood							x	xxx	xx	x		

(Source: DDPCC, 2019)

Table 6 shows the remarks of potential (x: low), (xx: moderate) and (xxx: high) flood risk levels (DDPCC, 2019).

During flooding. DDPCC organizes various rescue teams during flooding to help move victims from their properties to high safety areas.

> *'They persuade teams of the Local Government to prepare the required relief money and supplies according to elaborate field data collection for all flood victims using a specific flood relief announcement from every sector. They then report to the governor of the Xay District'* (Chom, 2019).

Post-flood. Most of the Local Government practices focus on drainage improvement recovery in urban areas and require funds from various sources to achieve recovery efficiency.

> *'After the great flood occurred in 2017, the Local Government moved the locals to new village areas and supported them using the master plan, technical assistance, budget allocation, and building assistance for those flood victims with the new houses. The resilience concept for building back better is practised by participating in responsible line offices. Youth volunteers helped with the labour, and the Local Government supported the best quality materials'* (Pub, 2019).

DISCUSSION

Strengthening the Factors for ORFRM

The methods and analysis can show the output result to recommend for ORFRM in the Xay District. In a specific way. The Local Government could strengthen ORFRM by establishing the strict flood control management, legislation and planning for subsequent and actual actions. Additionally, the Local Government must embrace the ORFRM in order to serve as a model for local engagement in routine implementation. The Local Government may prioritise all 26 ORFRM factors in place to ensure the work's sustainability.

Table 7. Strengthening the Factors for ORFRM in All Three Flood Cycles (Before, During and After)

No.	Factors	Strengthening the Factors for ORFRM
1	Law, legislation, policy and regulation	Prepare detailed flood policy and law and restrict illegal persons
2	Human resources development	Maximise and further develop the abilities of the LG staff in the meteorology and hydrology
3	Budget allocation	Establish enough flood funds and build alternative sources of local conditions.
4	Equipment and technology preparedness (such as rescue resources)	Store enough necessary tools before a flood emergency and stock the warehouse with equipment ready for usage throughout all seasons
5	Rescue vehicles (such as boats, helicopters and trucks)	Store enough rescue vehicles and perform routine exercises and acquire helicopters to reach those areas inaccessible by land vehicles and perform emergency rescue
6	Meteorological and rainfall assessment	Monitor regularly the rainfall data and water level and ensure accurate early warnings and alerts
7	Geographical characteristic assessment	Improve the knowledge of Geographic Information Systems focusing on mountain areas
8	Deforestation assessment	Conduct reforestation in upstream of rivers but try to financially support tree planters in Xay District
9	Urban plan practice assessment	Restrict urban planning regulations and building codes and practice resiliency and the concept of 'building back better' after the flood damage through structural and non-structural methods
10	Local population control	Allocate the essential places to other areas and impose high tax for external populations in risk areas
11	Land-use change assessment	Conduct zoning risk assessments that integrate the flood management policy and spatial land use planning
12	Experience and previous risk assessment	Review previous flood database and conduct empirical analysis for future applications
13	Time assessment (before, during and after) and immediate flood prevention, rescue and recovery	Assess the earliest time for rescue teams during emergencies; engage in suitable plans; and real acts of recovery and plan for reconstruction in short, medium and long operations
14	Early warning systems and prediction equipment (such as signs, signals and networks)	Use smartphones to track the flood and disseminate early warnings all the time and conduct extreme weather forecasting, monitoring and routine acts and work with teams to provide safety 24 hours a day and 365 days per year
15	Flood awareness, education, training and information sharing and dissemination	Integrate flood education in schools at all levels, perform regular drills in real places, conduct simulations with the LG staff and the locals and disseminate information to all forms of media via many sources (e.g., television, radio, newspaper and social media).
16	Flood data collection and analysis	Perform flood data collection and analysis as compulsory factors of routine review for future preparedness and conduct post-flood assessments

No.	Factors	Strengthening the Factors for ORFRM
17	Flood map documents and map analysis	Analyse the flood hazard maps, including historical and potential future events
18	Infrastructure monitoring and maintenance (dike and bank erosion protection and road safety)	Make strong engineering infrastructures within the available budget and maintain efficient methods with reasonable points to avoid further costs
19	Cleaning programmes for canals and drainage systems	Conduct programmes for the improvement of drainage capability in urban areas and encourage the locals' participation
20	Pumping stations and mobile pumping	Consider building flexible, accessible and suitable types of pumping stations in urban areas
21	Flood zones, plains and flood bypass	Ensure that the LG policies cater to flood zones or flood bypass and identify the link between factors for land acquisition and resettlement decisions
22	Evacuation procedures and surveying evacuation routes	Survey the evacuation routes before the possible occurrence of flood, determine the high safety areas and perform regular drills that involve the public and the locals
23	Storing food and drinking water	Store food and drinking water that can last for 3 days to help the victims and rescue teams
24	Flood shelter	Survey and allocate suitable buildings for shelter in high safety areas
25	Establish various teams (such as medical, relief, security, transport and recovery using the resilience concept of 'building back better')	Form various teams that can monitor flood impact at the local level and perform regular exercises in the local, provincial and national levels for professionals
26	Overall risk regular inspection, measurement and monitoring	Practice sustainable action, integrate the bottom–up and top–down approaches and try to combine all 26 factors for ORFRM to achieve long-term solutions

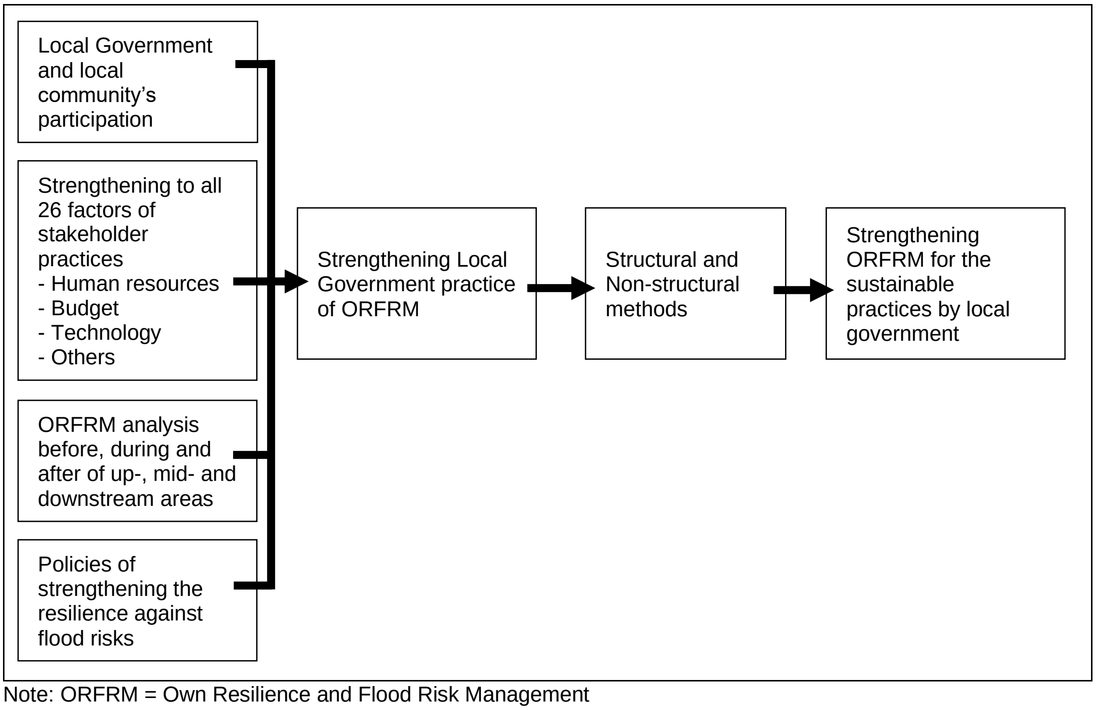
Planning for Local Government's Structural Method for ORFRM

The Local Government may propose ideas to address discharge capacity issues and to improve conditions along the Kor River. In the upstream basin, heavy rainfall results in significant river discharge and overflow. The designs must involve dike construction, erosion protection, channel dredging, and channel expansion due to the Kor River's severe bottlenecks and sedimentation. The meander shortcut strategy contributes to the quick discharge of floodwaters from urban areas in Xay District, thereby minimising flood damage. Additionally, reservoirs that store torrential rain may have an effective release capacity, preventing flooding caused by storms and torrential rain.

Planning for Local Government's Non-Structural Method for ORFRM

The flow allocation/distribution plan should incorporate steps in the higher reaches of the river basin that would limit the scale of the ORFRM measure downtown and hence the amount of floodwater flowing into urban areas adjacent to the basin. Additional infrastructures (e.g., law enforcement, examination of urban planning practises, early warning systems, retention pond, dam, and reservoir) may be required to mitigate flood discharge from the higher area. Additionally, the Xay District may require green infrastructure and riverfront parks. ORFRM, as a non-structural method, could be developed in a routine manner (e.g., before, during, and after) in terms of short, mid, and long-term measurement.

ORFRM's Model for The Sustainable Practices by Local Government in Xay District



Note: ORFRM = Own Resilience and Flood Risk Management

Figure 3. ORFRM's Model for the Sustainable Practices by Local Government in Xay District

This model demonstrates how the Xay District should consider a plan for integrating ORFRM in present local government practices in addressing, as well as the issues that necessitate the collaboration of several sectors under the Local Government to avoid floods. It also proposes the preparedness strategy for future floods events by taking long-term efforts with the help of all stakeholders and including stakeholders in normal tasks.

Furthermore, ORFRM's model in the Xay District has the potential to be a foundational idea in flood education, awareness, training, and practise. It may make use of modern technology to assist with institutional support. Additionally, it can help enhance flood forecasting, early warning systems, physical infrastructure, flood response, proper financing, and insurance, all of which contribute to a stable and rapid recovery and long-term planning. Retaining the Kor River and constructing a reservoir may be the greatest long-term alternative for postponing the peak flood concentration and preventing flood damage. Additionally, they can assist in reinforcing the resilience concept of "rebuilding better." Upstream reservoirs for retention may be developed. In the midstream area, dike works (levee bank elevation) may be constructed. The downstream area may benefit from river improvements such as bank protection and a shortcut for rapid discharge in the main rivers. These proposals could involve the development of green infrastructure to aid in the absorption, filtering, and delaying of rainwater runoff, hence minimising urban floods in the Xay District.

CONTRIBUTION OF THE STUDY

This study contributes to the existing knowledge about Local Government procedures and takes into account the viewpoint of the residents in order to strengthen ORFRM in the Xay District. It could also be used to support and improve existing theories and research. A study conducted in the Indian state of Uttarakhand found that, the Local Government is bound to establish plans and engage all stakeholders at the national, provincial, and local levels to promote collaborative governance (Dash & Punia, 2019). This research could aid in the adoption and adaptation of all 26 ORFRM elements by bridging the gap between policymakers, practitioners, community leaders, and residents. The outcomes of this study confirm the efficacy of the actions underpinning the notion of 'build back better' in fostering long-term growth in this district at all levels and stages. There is a need for focused action within and across sectors by stakeholders into attending four priority areas, understanding flood risk, strengthening flood risk governance to manage, investing in flood risk reduction for resilience, and enhancing flood preparedness for effective response and to "Build Back Better" in recovery, rehabilitation, and reconstruction (UNISDR, 2015). It ensures that measures are adopted so that the people of the Xay District will not be vulnerable to the next floods. They could be able to help other countries build resilience and reduce flood danger (Chau et al., 2014). They strengthen the resilience of the community against the risks and threats as well as the impacts of flood.

This study contributed to the body of knowledge on flood risk in several developing countries, including Xay District, Lao PDR. Additionally, it demonstrates the importance of incorporating local engagement in the development of response strategies for predicting and managing extreme weather risks. These actions and all 26 ORFRM factor point to the importance of increasing the Local Government's resilience in the research area and reducing flood risk in communities. Building back in the standard level would not be enough to support flood risk management and prevention with extreme weather risks with built back better as a high standard in the future. Currently, the local government knew about many factors that might improve for the next step as sooner, building back better and building for better resilience necessary in all sectors include construction industry like hard engineering is very crucial for local life prevention, save properties as well by did not disturbance for socio-economic growth development interrupt by the flood risks and impacts.

CONCLUSION

The purpose of this study is to evaluate and strengthen the Local Government practise of ORFRM in the upstream, midstream, and downstream areas in Xay District before, during, and after floods. The findings indicated that ORFRM must include flood risk prevention during periods of unusual weather and is mostly caused by the discharge capacity of three major rivers and the Xay district areas. The assessment results indicated that each of the 26 ORFRM variables (Table 5) influences Local Government practise. The Local Government practise has made fewer investments in human resource development and has shifted its priority to the quick implementation of relief actions and flood response plans.

To adopt and adapt by local government to guarantee that ORFRM is suited for future sustainable action, policymakers should reinforce the 26 factors (Table 7) that support effective Local Government implementation of additional action. Additionally, they must implement policies and plans for both structural (e.g., discharge capacity, river improvement and shortcuts, reservoir, and dam construction) and non-structural measures (e.g., early warning system, law enforcement, education, awareness, budget, land use planning, urban planning and suitable retention ponds). Participation of native populations must also be encouraged. Additionally, the Local Government should improve the processes governing ORFRM actions prior to, during, and after floods in upstream, midstream, and downstream sectors. However, ORFRM's model for Local Government practise sustainability needs be revised, and the Xay District results should be extended in other areas.

REFERENCES

Brown, K. (2013) Global environmental change I: A social turn for resilience?. SAGE Publishing. Page 2. Retrieved October 3, 2021 from https: //core. ac.uk/ download/ pdf /43096988.pdf.

Center for Excellence in Disaster Management and Humanitarian Assistance. (2017) Lao PDR Disaster Management Reference Handbook. Retrieved December 25, 2019 from https://reliefweb.int/report/lao-peoples-democratic-republic/lao-pdr-disaster-management-reference-handbook-2017.pdf.

Chau, V. N., Holland, J. and Cassells, S. (2014) Institutional structures underpinning flood management in Vietnam. International Journal of Disaster Risk Reduction,volume 10, Pages 341-348, ISSN 22124209. DOI 10.1016/j.ijdrr.2014.10.008.

Chom. (pseudonym). (2019, November 17). Interview one staff from all who work at DDPCC in the Xay District.

Creswell, J. W. (2007) 4th Edition Research Design, Qualitative, Quantitative, and Mix Methods Approaches. SAGE Publication. Los Angeles. Retrieved December 22, 2019 from https://gul.gu.se/public /pp/public file archive/archive.html? published ItemId.pdf.

Dash, P. and Punia, M. (2019) Governance and disaster: Analysis of land use policy with reference to Uttarakhand flood 2013, India. International Journal of Disaster Risk Reduction, volume 36. Start page 101090, ISSN 22124209. DOI:10.1016/j.ijdrr.2019. 101090.

Forman, J., Creswell, J. W., Damschroder, L., Kowalski, C. P. and Krein, S. L. (2008) Qualitative research methods: key features and insights gained from use in infection prevention research, Am J Infect Control, Volume 36, Issue 10, Pages 764-771, ISSN 1527-3296 (Electronic) 0196-6553 (Linking). DOI:10.1016/j.ajic.2008.03.010.

Govindarajulu, D. (2020) Strengthening institutional and financial mechanisms for building urban resilience in India. International Journal of Disaster Risk Reduction, Vol 47. DOI:10.1016/j.ijdrr.2020.101549.

Holling, C. S. (1973) Resilience and stability of ecological systems. Annual Review of Ecology and Systematics, volume 4, pages 1-23.

Ibrahim, F. S. and Esa, M. (2019) The Implementation of risk management plan: towards safer hillside development project. MCRJ Special issue Vol.3 / no.1 / 2018. Retrieved October 11, 2021 from https://www.researchgate.net/profile/Farah-Ibrahim/publication/ 333338394 _ THE_ IMPLEMENTATION _OF_ RISK_ MANAGEMENT_PLAN_ TOWARDS_SAFER_HILLSIDE_DEVELOPMENT_PROJECT /links/5ce7715d9285 1c4eabba2f14/THE-IMPLEMENTATION-OF-RISK-MANAGEMENT-PLAN-TOWA RDS-SAFER-HILLSIDE-DEVELOPMENT PROJECT.pdf?origin=publication_detail.

Intergovernmental Panel on Climate Change [IPCC], (2007) The physical science basis; working group I contribution to the 4th assessment report of the Intergovernmental Panel on Climate Change. DOI:Available from: http://www.ipcc.ch/ipccreports/ar4-wg2.htm [2019.16.October]

Law on Disaster Risk Management in Lao PDR. (2019) Law on Disaster Risk Management in Lao PDR. Retrieved October 10, 2021 from https://data.opendevelopmentmekong .net/ dataset/6d5aedf9- 9830 - 4ac9- b635- 5b9fd188c982/resource/38fe945d-3c66-458b-b21a-380ded90eddf/download/712019.pdf

Oubennaceur, K., Chokmani, K., Nastev, M., Lhissou, R. and Alem, A, E. (2019) Flood risk mapping for direct damage to residential buildings in Quebec, Canada. International Journal of Disaster Risk Reduction. Volume 33 (2019) pages 44–54.

Pub. (pseudonym). (2019, November 25). Interview one staff from all who work at DDPCC in the Xay District.

Sarker, M. N. I., Peng, Y., Yiran, C. and Shouse, R. C. (2020) Disaster resilience through big data: Way to environmental sustainability, International Journal of Disaster Risk Reduction. Vol 51, start page 101769, ISSN 22124209. DOI: 10.1016/j.ijdrr.2020.101769

Tariq, M. A. U. R., Farooq, R., and Giesen, N., V. D. (2020) A Critical Review of Flood Risk Management and the Selection of Suitable Measures. MDPI, applied sciences. Retrieved October 11, 2021 from https://mdpi-res.com/d_attachment/applsci/applsci-10-08752 / article_deploy/applsci-10-08752-v3.pdf.

Thanthathep, K., Komany, S., Pauc, J., Kommalien, K., Insisiengmay, T., Sinsupan, T., Keokhamphoui, S. and Murphy, K. (2016) Community-Based Disaster Risk Reduction (CBDRR) Manual in Lao. Retrieved March 5, 2020 from https://reliefweb.int/.../lao-peoples-democraticrepublic/community-based-disaster-risk.pdf.

UNDP (2018) Contingency Plan Lao PDR: Floods, Vientiane: UNDP Lao PDR. Retrieved October 11, 2021 from https://www.google.com/search?q=In+Lao+PDR.+Floods+ were+ most + frequent + occurrences +during+the+monsoon+season+from+May+to+ October&oq=In+Lao+PDR.+Floods+were+most+frequent+occurrences+during+the+m onsoon+season+from+May+to+October&aqs=chrome..69i57j69i59.1774j0j7&sourceid =chrome&ie=UTF-8.

UNDRR (2019) Disaster Risk Reduction in Lao PDR; Status Report 2019. Retrieved October 11, 2021 from https://reliefweb.int/report/lao-peoples-democratic-republic/disaster-risk-reduction-lao-pdr-status-report-july-2019.

United Nations [UN], (2005) Lao Public Administration Profile, Division for Public Administration and Development Management (DPADM). Department of Economic and Social Affairs (DESA), Pages 9-10. Retrieved January 5, 2021 from www. fredsakademiet.dk› lord›_pdf›Laos_2005.

United Nations [UN], (2012) The future we want, Outcome document of the United Nations Conference on Sustainable Development, Rio+20. Page 48. Retrieved October 3, 2021 from https://sustainabledevelopment.un.org/content/documents/733FutureWeWant.pdf

United Nations Office for Disaster Risk Reduction [UNISDR], (2010) Final Report of United Nations International Strategy for Disaster Reduction (UNISDR) Secretariat Evaluation. Dalborg. Global Development advisors. DOI: https://www.unisdr.org/ files/12659_ UNISDRevaluation2009finalreport.pdf

United Nations Office for Disaster Risk Reduction [UNISDR], (2012) Country assessment report for Lao PDR. Strengthening of Hydrometeorological services in Southeast Asia. Page 14. www.unisdr.org › files › 33988_countryassessmentrepo.

United Nations Office for Disaster Risk Reduction [UNISDR], (2015) Sendai Framework for Disaster Risk Reduction 2015-2030. Retrieved October 03, 2021 from https:// www. undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030.

Walkling, B. and Haworth, B. T. (2020) Flood risk perceptions and coping capacities among the retired population, with implications for risk communication: A study of residents in a north Wales coastal town, UK. International Journal of Disaster Risk Reduction. Vol 51, start page 101793, ISSN 2212-4209. DOI: 10.1016/j.ijdrr.2020. 101793. URL:https://www.ncbi.nlm.nih.gov/pubmed/ 32834976. Pages 1-5

Williams, L., Joy B., A. M. and Florio, A. (2020) Major storms, rising tides, and wet feet: Adapting to flood risk in the Philippines. International Journal of Disaster Risk Reduction. Vol 50, start page 101810, ISSN 22124209. Doi: 10.1016/j.ijdrr.2020.101810. Pages 1-5

Xay District Disaster Prevention and Control Committee [DDPCC], (2019) Report summary of Xay District, Oudomxay Province in 2017-2018. (In the Lao language)

GUIDE TO AUTHORS

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CODIFICATION AND APPLICATION OF SEMI-LOOF ELEMENTS FOR COMPLEX STRUCTURES

(FULL NAME) Ahmad Abd Rahman[1,2], Maria Diyana Musa[2] and Sumiana Yusoff[2]
[1]Department of Quantity Surveying, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Sarawak, Malaysia
[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)*

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

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

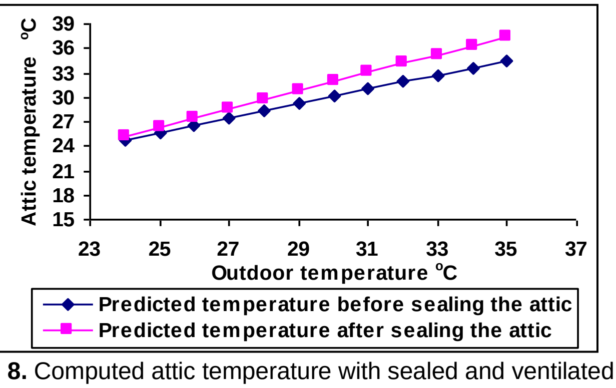

Figure 8. Computed attic temperature with sealed and ventilated attic

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

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

Table Line: 0.5pt.

Table 1. Recommended/Acceptable Physical water quality criteria

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

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

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

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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)

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

Siti Hawa, H., Yong, C. B. and Wan Hamidon W. B. (2004) Butt Joint in Dry Board as Crack Arrester. Proceeding of 22nd Conference of ASEAN Federation of Engineering Organisation (CAFEO 22). Myanmar, 55-64.

Skumatz, L. A. (1993) Variable Rate for Municipal Solid Waste: Implementation, Experience, Economics and Legislation. Los Angeles: Reason Foundation, 157 pp.

Sze, K. Y. (1994) Simple Semi-Loof Element for Analysing Folded-Plate Structures. Journal of Engineering Mechanics, 120(1):120-134.

Wong, A. H. H. (1993) Susceptibility to Soft Rot Decay in Copper-Chrome-Arsenic Treated and Untreated Malaysian Hardwoods. Ph.D. Thesis, University of Oxford. 341 pp.

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MCRJ Volume 35 | No.3 | 2021

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ISSN 1985-3807
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eISSN 2590-4140
9 772590 414000