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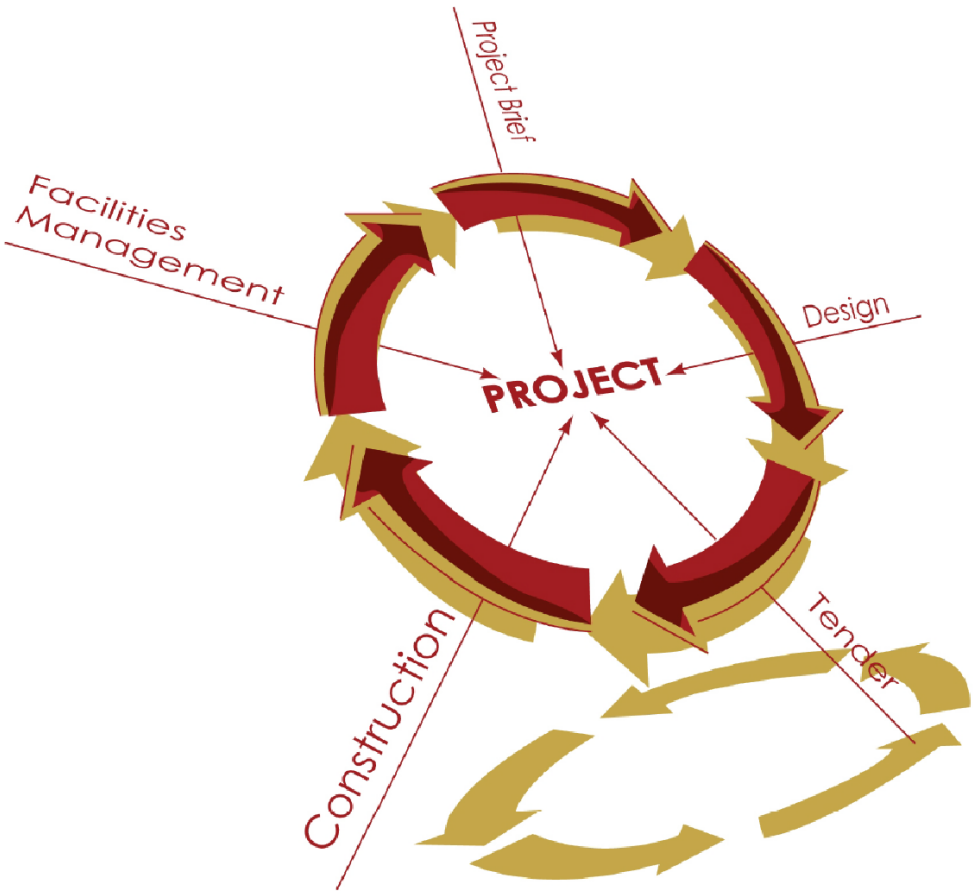

CREAM CONSTRUCTION RESEARCH INSTITUTE OF MALAYSIA
CIDB MALAYSIA

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

Introduction

Welcome to the Special Issue of the Malaysian Construction Research Journal (MCRJ) in conjunction with the International Conference on Built Environment and Engineering (IConBEE) 2021. This conference was organised by Universiti Tun Hussein Onn Malaysia (UTHM) and Universiti Teknologi MARA (UiTM) and was held virtually on 1st – 2nd April 2021. This biannual event aims to be a leading stage for academicians, researchers and practitioners to highlight and discourse significant innovations, trends and challenges related to the built environment. The central theme of the conference 'Driving Construction & Environment Excellence' is intended to bring forward innovative ideas towards greater technologically advanced sustainable construction industry achievement.

This Special Issue of Malaysian Construction Research Journal (MCRJ) highlights extended articles which have been selected from papers in IConBEE 2021. A total of 20 papers from numerous backgrounds in the built environment and engineering discipline especially for the process of reforming the industry to drive towards an excellent future.

Accepted papers covered five conference tracks under built environment and engineering which are Sustainable Construction Management, Environment Management & Humanities, Integrated Technology & Engineering, Architecture and Urban Development, and Sustainable Real Estate & Facilities Management. Each paper that was presented and published in this conference had undergone a systematic review process by selected reviewers who are experienced and well versed at his/her own applicable subject area.

Editorial Advisory Board

Secretariat Special Issue

Editorial

Welcome from the Editors

Welcome to this special issue in Malaysian Construction Research Journal (MCRJ) for the International Conference on Built Environment and Engineering 2021 (IConBEE 2021). We would like to express our sincere gratitude to our contributing authors, reviewers, organisers and readers.

This special issue in MCRJ for IConBEE 2021 contains twenty (20) interesting papers covering the theme of "Driving Construction & Environment Excellence". It is hoped that the readers would greatly benefit from this special edition on matters regarding all aspects of Built Environment and Engineering. Brief introduction of each article is given as hereunder:

Goh Kai Chen et al., have presented on how this study aims to address gap with three distinct objectives: first, to investigate the issues of cost overrun in construction projects that BIM is capable of intercepting; second, to investigate current practises in addressing cost overrun; and third, to identify the use of BIM to control cost overrun issues in construction projects.

Seow Ta Wee et al., have identified the purpose of this research was to identify the current safety practices of construction project sites in Yemen, to identify the factors causing safety issues on construction project sites in Yemen, and to suggest strategies for reducing safety problems on construction project sites in Yemen. The research was carried out in Yemen's Sana'a and Amran. The quantitative research method was used to conduct a questionnaire survey.

Aina Mardia Sallehuddin et al., have explained that technology adoption in the industry especially among SMEs is seemingly impossible as there are several complex technical, cultural and socio-economic factors that also became factors that technology adoption has not always been successful and made technology absorptive capacity (TACAP) barely happened. However, previous researches highlight the positive effect of control of work stress towards the organisation through high motivation level, activation and excellent mental health enhance continuous learning and improvement in the organisation. Meanwhile, TACAP is known as a learning process too. Hence this research would like to explore the relationship between work stress and TACAP among SMEs in construction projects.

Narimah Kasim et al., have explained on the significant findings that most impacted the IBS implementation in the housing projects due to COVID-19 were the new safety regulations, improved supply chain, and reduced unskilled foreign workers. In addition, the respondents recommend some new practice approaches for IBS implementation including new incentives allocation, up-to-date technology implementation, and skillful workers utilisation.

Sulzakimin Mohamed et al., have studied the notion that failure to collect waste according to the schedule appropriate and problem of waste liquid dropping after collection are needed to improve for the solid waste management in Kota Samarahan. Furthermore, this study can encourage the construction industry to increase their attention on increasing the

awareness of waste management and help to the better future sustainable solid waste disposal management.

Sharifah Rahama Amirul et al., have shown the notion of Maslow hierarchical needs theory into the setting of retirement villages. The proposed framework of this paper offers a structured and thorough understanding of aged elderly requirements and aspirations; starting with the most fundamental of aged requirements and progressing to the highest desire of having a high quality of life during their golden years, which presents unique prospects for making a theoretical contribution to the requirements of the ageing population and improving RV sustainability.

Mohd Yamani Yahya et al., have explored the main barrier to BIM collaborative design was a lack of coordination among construction stakeholders, which resulted in additional impediments during the design stage. As a result, it is advised that more training be offered to construction actors to enhance awareness of the benefits of adopting BIM in construction projects. However, the respondents stated that with the involvement of government regulation, the use of BIM in the Malaysian construction industry would expand, which would help the construction firm in terms of enhancing collaboration and communication between the construction participants.

Mohammed Hamed Al-Salmi et al., have presented on the use of information technology in management systems in Oman, such as in construction industry, e-government, e-service, e-payment, and e-education, has recently improved. The Omani environment for performing audits is still developing. Today, leveraging information technology to improve the audit performance environment has become an essential and anticipated topic in the audit field. Although audit performance improvement is a sort of audit that focuses on analysing the efficacy of internal and external economics, it is not distinctive from finance audit in any way. This paper intends to analyse if information technology may help the Oman public sector achieve its organisational goals in an environment where audit performance can be improved. Additionally, this study used software analysis (PLS) and (SPSS) methods to investigate the connections between information technology and audit performance.

Hasniza M. Yusof et al., have demonstrated on the lack of amenities at the Klang Valley railway station that include safety and security, upkeep, comfort, physical facilities, accessibility, environment, and communication can encourage users to choose their private vehicles as a daily mode of transportation. This study's goal is to evaluate the Klang Valley railway station's accessibility in terms of Facilities Management (FM), utilising criteria that are unique to FM and are focused on people, places, processes, and technology in addition to accessibility criteria.

Lim Wei Guan et al., have discussed the phenomena of illegal solid waste dumping have impacted the solid waste management efforts. Therefore, recycling is seen as one of the methods to reduce the solid waste that ends up in the landfills. The separation of solid waste at source enables to separate the recyclable solid wastes from the domestic wastes, thereby minimising the volume of waste into the landfills. Nevertheless, the recycling rate is still low in Malaysia, as can be seen from the ineffectiveness of the solid waste separation at source method. Although many recycling programmes have been conducted to encourage the public to recycle, the recycling rate is still undesirable.

Pamor Gunoto et al., have shown that the level of pollution caused by combustion engines every day is increasing in big cities such as Batam city. Therefore, the use of electric vehicles as Eco-Friendly transportation is an urgent need. The biggest challenge for electric vehicles as main transportation is the short distance travelled due to the limited electric power battery and the longer time for battery charge time. It can be overcome by charging the battery at any time and wherever the electric vehicle. In this study, electric bicycle is uses a battery with 3 (three) ways of charging, which are using a solar panel when stopping/parking, a DC generator when running and a 220 V PLN power while in the room/house.

Indera Shahrul Mat Radzuan et al., have identified engagements between players such as government sector, corporate organization, institutional, NGOs and community are very crucial and have been identified as one of the most important solutions to overcome environmental issues. The success, and indeed the existence, of most environmental efforts depend on volunteers. This research focuses on how corporate volunteering emerged as a tool to promote and empower the environmental sustainability programmes in the state of Johor. This research evaluates the role of companies (Kumpulan Prasarana Rakyat Johor Sdn. Bhd., Johor Corporation, SWM Environment Sdn. Bhd., Medini Iskandar Malaysia and Ranhill SAJ Sdn. Bhd.) in conducting their corporate volunteering for sustainable environmental-based programme. It employed a mixed method approach by using interviews with executives and questionnaire survey with the workers from each organisation.

Haryati Shafii et al., have discussed the problem statement on the degree of safety and health practices in different sizes of construction project could influence the accident rate among workers at construction site. The objectives of the research were to identify safety and health practices in different sizes of construction project and to propose the method for improving safety and health in different sizes of construction project. This research was carried out in Johor especially in Batu Pahat and Kluang, targeted on small scale (G1-G3 contractor) and large scale (G6 – G7 contractor) of construction projects for identifying safety and health practices among worker and contractor.

Hery Irwan et al., have presented on the relationship between lot-sizing and scheduling must be considered simultaneously during planning decision-making to obtain global optimal solutions. Numerous literature studies on integrated lot sizing and scheduling problems, including streaming lot, complex setup, resource constraint, job sequence, and completion date over time, have been published. The objective of this study is to review and identify current research and problems faced in the production floor related to interaction between lot sizing and scheduling.

Nisamini Subramaniam et al., have explained on the development of the construction industry increases buyer perception on Malaysia projects. The higher the quality achieved in building projects attracts the attention of buyers. Residential projects are considered as the highest type of construction industry, which grows with the high number of buyers and investors. However, high-rise residential house owners have quality issues in terms of defects in their units among the residential projects. The defects which occur in high-rise residential stand in different types of categorising. Thus, this research carries the objective of developing a framework on QLASSIC to reduce defects in high rise residential projects with data collected from respondents of Malaysia private residential developers who have won QLASSIC Achievement Awards from the year of 2015 until 2019.

Goh Kai Chen et al., have identified as a result of rising urbanisation, demand for critical utility services, including electricity, water, and telecommunication, is increasing. As utilities are buried under the earth, maintaining and installing become more complex. There are numerous unsuccessful excavation accidents recorded annually all around the world. Damage impacts include project delays, financial losses, environmental pollution, and fatal and nonfatal injuries. Eventually, it showed how important to map underground utilities with existing practices and technologies. Therefore, this paper presents a comprehensive review of current practices in underground utility detection in Malaysia and worldwide are compared.

Intan Syafinar Jamaludin et al., have studied the risks of losing its cultural heritage due to rapid urbanisation, deterioration, and destruction of heritage sites, growing tourism, and natural disasters. One of Melaka's key shocks and stresses listed under its 100 Resilient Cities programme is the risk of losing World Heritage Status and its intangible heritage. Conducive to achieve a sustainable community, it is essential to conserve the living heritage of the Portuguese community by understanding their perception of the conservation of community cultural heritage. Hence, the objective of this paper is to analyse community understanding and perception towards safeguarding community cultural heritage.

Ainul Nabeel Fikri Ainul Zuhairi et al., have presented on the objectives of this study were to investigate the level of employee motivation in the remote working environment in the construction industry during the pandemic crisis, identify the effects of task-oriented and relation-oriented leadership behaviour in motivating employees during the pandemic crisis and determine the moderating role of digital readiness for the relationship between leadership behaviour and employee motivation. A questionnaire survey to 185 respondents was utilised in the data collection exercise. Various statistical analyses were done by using the statistical package for the social sciences (SPSS) software. The findings indicated that task-oriented and relation-oriented leadership behaviour was acquired to maintain employee motivation in a remote working environment during crises.

Nur Shahirah Nadhilah Wahab et al., have identified on the strategic change through the development of smart cities is important to overcome various urban challenges. However, it is still a challenge for the city key players to convey the smart city strategies into actual projects. Past research has pointed out the importance of readiness at the organisational level. Therefore, this study focuses on briefly discussing the organisational readiness for change theory to better understand the fundamentals of the concept. Furthermore, this study discusses the organisational readiness in digital innovation and relating it to the smart city perspective.

Md Asrul Nasid Masrom et al., have identified that by utilising the BIM process, the facilities management players could plan, coordinate, and monitor in an effective integrated approach. This is one of the many benefits that they could gain and result in increased efficiency. Despite these benefits, the implementation of BIM in the Malaysian Facilities Management (FM) industry is still at an infant stage. The objective of the study is to identify the challenges and investigate the strategies to improve the adoption of BIM technology in FM mainly based on developer insights. This study was conducted using a qualitative method by interviewing three (3) representatives from facilities management companies around Johor. All the feedback and information gained from the interview session is analysed using a content analysis method. The result of the interview addressed that the challenges adopting BIM in FM include human factor, process factor, cost factor, technology factor and risk factor.

IMPLEMENTING BUILDING INFORMATION MODELLING (BIM) FOR CONTROLLING COST OVERRUN IN CONSTRUCTION PROJECTS

Kai Chen Goh[1], Mohammed Yahya Al-Amri[1], Hun Chuen Gui[2], Sulzakimin Mohamed[1], Md Asrul Nasid Masrom[1] and Tien Choon Toh[3]

[1]Department of Construction Management, Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Malaysia.

[2]Department of Quantity Surveying, Faculty of Built Environment, UNIMAS, Kota Samarahan, Sarawak, Malaysia.

[3]Department of Surveying, Lee Kong Chian Faculty of Engineering and Science, Universiti Tunku Abdul Rahman, Sungai Long Campus, Selangor, Malaysia.

Abstract

Hitherto, the construction industry has been the most important contributors to the socioeconomic development of a nation. Around 46.8 percent of public sector projects and an even more worrisome 37.2 percent of projects in private sector were completed on time and within budget. In the past, few studies have focused on the implementation of BIM as an effective cost control initiative undertaken by Malaysian contractors, particularly those whose operations were concentrated in the central region. Consequently, this study aims to address this gap with three distinct objectives: first, to investigate the issues of cost overrun in construction projects that BIM is capable of intercepting; second, to investigate current practises in addressing cost overrun; and third, to identify the use of BIM to control cost overrun issues in construction projects. In order to collect empirical evidence, questionnaires were distributed to 331 CIDB G7 contractors registered in the Kuala Lumpur region; 104 of these contractors responded, giving this study a respectable sampling response rate of 31 percent This study's findings provide evidence that there is broad consensus regarding the causes of cost overruns that BIM can prevent. In addition, this study has successfully uncovered the practises currently utilised by contractors to control construction project cost overruns. Lastly, it has been observed that the adoption and implementation of BIM technology has a significant impact on preventing project cost overruns.

Keywords: *Construction project; Building Information Modelling (BIM); cost overrun.*

INTRODUCTION

Globally, the construction industry contributes significantly to a nation's socioeconomic development. Similarly, in Malaysia, the construction industry is considered a vital contributor to the nation's socioeconomic development (Rahman, Memom, & Karim, 2013). Malaysia is a rapidly developing Asian nation that has experienced rapid economic growth since the 1970s. Consequently, this established industry has consistently contributed between 3 and 5 percent of the nation's total Gross Domestic Product (GDP). From the 1970s to the mid-1990s, the construction industry experienced a rapid expansion (Endut, Akintoye, & Kelly, 2009).

Along with the rapid paradigm shift towards Industrial Revolution 4.0, also known as IR4.0, the Building Information Modelling (BIM) approach is continuously refined based on the observed and anticipated results of its adoption. BIM is a complete set of design documents and symmetric, interconnected data on the entire building that are stored in an integrated database. Any modifications to the model are immediately reflected in the rest of the project through the eyes of all stakeholders. In other words, BIM is a technology that can improve the conceptualization and construction of infrastructure. In its early stages, BIM was

distinguished by representing elements rather than lines, curves, and arcs. However, it has significantly evolved into a powerful tool capable of "model analysis, clash detection, product selection, and even the conceptualization of the entire project." (2014) (Blanco & Chen).

Unfortunately, project cost overruns are a worldwide phenomenon in the construction industry, with a staggering number of projects failing to complete within budget for a variety of reasons. In a global study on the performance of construction projects, cost overrun was identified as the most significant challenge, with nine out of ten projects reporting budgeted costs that were exceeded by 50 to 100 percent (Azman & Adeleke, 2018). Nearly one-third of client complaints related to project cost overruns in developed economies like the United Kingdom's construction industry. Similarly, the Malaysian construction industry faces a grave problem with project cost overruns, as only 46.8 percent of public sector projects and an even more alarming 37.2 percent of private sector projects were completed successfully within the budgeted amount (Belachew, Mengesha, & Mohammed, 2017). The construction industry in Malaysia is plagued by persistent issues, such as poor time and cost performance, inadequate waste management, low productivity, and an overreliance on foreign workers. Time and cost poor performance has been singled out as the most serious of these underlying challenges (Ahady, Gupta, & Malik, 2017). The Malaysian construction industry's pervasive poor time and cost performance necessitates additional localised research into the possible solutions (Endut et al., 2009).

Henceforth, BIM has been shown to facilitate problem-solving scenarios, the government will now encourage construction firms to adopt BIM in their projects. For example, BIM can provide early detection, which could significantly reduce disputes between the numerous construction players and manage the correct design and quantity for each structural and non-structural component in order to reduce project delays (Latiffi, Mohd, Kasim, & Fathi, 2013). BIM facilitates the integration of disparate practises, improves sustainability, reduces poor quality, and acts as a synergistic catalyst for the continuously evolving construction processes. In a separate study, BIM was found to resolve significant delays caused by poor design, inadequate communication between project parties, and inadequate scheduling and planning in the Jordanian construction industry (Btoush & Harum, 2017). Therefore, BIM has been suggested as the optimal tool for resolving problems within the domain of schedule delay analysis (Chou & Yang, 2017).

LITERATURE REVIEW

Cost Overrun issues in Construction Projects

Deprived site management, commonly unanticipated ground conditions, unplanned variation orders, deprived verdict-making processes, frequent variations in design initiated either by the designers or project financiers, improper planning, exceptionally inclement weather conditions, low labour productivity, late payment, scarcity of labour supply, inexperience in handling project, issues with subcontractors, and scarcity of construction materials were frequently cited as causes of project cost overruns (Tahir, Haron, Alia, & Diugwu, 2017).

In addition, previous research has attributed cost overruns to cost underestimation, scope changes, unforeseen events, and poor contractor performance. However, neither exhaustive

nor tried-and-true solutions to these issues are provided. Cost overruns have also been attributed to "lack of contractor buy-in" and "underestimation of project budgets to win clearance." According to them, when first budgets are produced, the project's scope is not well-defined, and the majority of the information that would enable the project owner to generate correct estimations is simply missing. As a result, financial commitments are made too early in the project's life cycle. In addition, according to the majority of research findings, factors such as poor initial estimates, changes in the scope of work, project delays, fluctuations in material prices, and site location appear to contribute in varied degrees to cost overruns (Mulenga & Bekker, 2015).

International research was analysed to acquire a broader knowledge of the reasons of building project cost overruns. In Pakistan, variable raw material prices, uncertain manufactured material costs, high machinery costs, the lowest bid procurement technique, inadequate site management, and insufficient cost control were recognised as the top five causes of cost overruns (Azhar, Farooqui, & Ahmed, 2008). Due to various rework activities necessitated by design changes, erroneous original design, and accidental damages incurred during construction, Australia discovered that an additional 2.4% to 3.15 % of the original contract price had to be added on (Love & Li, 2000). According to research conducted in India, the primary reasons for cost and schedule overruns were inadequate project formulation, erroneous cost estimation, scope and work volume changes midstream, wrong vendor selection, and delayed project start-up. In private residential building projects in Kuwait, contractors' and materials-related concerns, owner's financial constraints, and faulty design were recognised as the primary reasons for cost overruns (Ramabhadran, 2018). In conclusion, Indonesian research reveals that the leading causes of cost overruns are inclement weather, inflationary material costs, inaccurate material estimates, project complexity, contractor lack of geographical experience, contractor lack of managerial type experience, and unfamiliarity with local regulations (Kaming, Olomolaiye, Holt, & Harris, 1997). Therefore, according to the aforementioned studies, cost overruns harm domestic and international undertakings.

Practices for Controlling Cost Overrun

The Project Control and Inhibiting-Factors Management Model (PCIM) presented a multi-faceted improvement model that includes: technical practices that incorporate incremental improvement steps, continuous innovation, and a holistic process view of a project that is capable of breaking down barriers between diverse groups involved in a project, establishing shared goals in project management, and ensuring optimization of all. Furthermore, contractors should ensure adequate construction planning and continuous monitoring of activities, set up stores for the storage of construction materials, control the quality of project activities, use approved sustainable materials, and implement organized work procedures to reduce construction project time and cost overruns. The consultants should actively check the quality of work to avoid any errors that may result in excessive rework. They should also speed up the assessment and approval of design modifications, the generation of payment certificates for contractors, and the facilitation of change orders (Danso & Antwi, 2012).

Cost target adherence is commonly recognised as one of the essential parts of the project management life cycle and the primary factor influencing the success of a project. Earned

Value Analysis (EVA) is utilised to evaluate the cost-effectiveness of various project types. Cost control, estimate, and budgeting are three interdependent cost-related project processes. Before a project begins, a detailed cost estimate will be developed for review by the stakeholders so that it can be collectively agreed as the cost baseline. Depending on the project's complexity, project cost management can range from being very easy to quite difficult. Consequently, this scenario necessitates the participation of multiple parties to correctly complete this challenging task (Ali & Kamaruzzaman, 2010).

BIM and Cost Overrun in Construction Projects

BIM applications differ throughout the broad scope of project activities. The adoption of BIM can be seen not only in the design visualization, but also in site planning and space utilization, activities scheduling, sequencing, and resources allocation, building services and intelligent systems coordination, infrastructures layout and fieldwork planning, operation and maintenance activities detailing, all of which will lead to the overall development and operation cost estimating.

Construction projects frequently exceed estimated costs due to insufficient cost monitoring and control procedures, resulting in losses for contract parties. There have been initiatives to enhance cost monitoring and management, but such efforts have not been very effective. It was proposed that BIM deployment in the UK may help to fix the challenges in practice. Although BIM compatible Quantity Surveying (QS) software technologies are available in the UK market, BIM has yet to be fully accepted by practitioners. It has been stated that the resistance to change among QS professionals stems from ambiguity, insecurity, and a lack of BIM expertise. Furthermore, it was discovered that construction businesses were still hesitant to use BIM due to the high cost of purchase and implementation (Sunil, Pathirage, & Underwood, 2017).

Nonetheless, BIM implementation is on the right track and outlines the prospects that emerge when 5D (integrating budgetary and cost information into a 3D model) is viewed as more than a quantity take-off activity. Practitioners presented an approach to incorporate 5D BIM into the design of building projects to achieve improved cost certainty. To that purpose, 5D BIM has created specialized technologies that supplement traditional cost planning procedures by precisely defining budgetary strategies from the early design stage, allowing cost overruns to be effectively handled as plans progress. 5D BIM allows users to optimize resource efficiency, which will drive the costs of buildings, infrastructures, heavy engineering, or land development in a favourable direction. Furthermore, the ability to view quantities and predicted prices during talks with contractors and subcontractors fosters confidence among the negotiation parties, which considerably helps the procurement process (Mitchell, 2012).

Previous research has further highlighted that visualization in construction design and integrating it with cost control measures is still in its incipient stage. Nonetheless, BIM offers a promising impact on that domain (Elbeltagi, Hosny, Dawood, & Elhakeem, 2014). Building on that, a comprehensive cost estimating, and monitoring model was presented. This cost model integrates with BIM designs and allows users to visualize the expected construction cost in different building elements and comprehensively compare it with what has been budgeted at different time intervals. In that sense, it leads to a powerful impact for

construction managers when dealing with cost-related information. It provided vital information to the stakeholders so that in any unexpected circumstances which may lead to the deviation from the planned budget, appropriate corrective actions can be deployed promptly.

RESEARCH METHODOLOGY

This research adopted a quantitative approach in the form of a questionnaire survey to address three objectives: first, to investigate the causes of cost overrun in construction projects which BIM is capable of intercepting; second, to investigate current practices in dealing with a cost overrun, and third, to identify the factors of using BIM to control cost overrun in construction projects. The study population was targeted at the highest echelon of contractors - Grade G7 - registered in Kuala Lumpur region under the Construction Industry Development Board of Malaysia (CIDB). Based on published CIDB report, this region regularly records the highest development activities in the aspect of new major construction projects, and therefore it is posited that BIM adoption rate would also be the strongest in this region. Respondents would include project managers, site managers, quantity surveyors, architects and project engineers. The sampling size (n) derived for this study is 331. A pilot study was carried out to identify potential problems before the actual survey. In this sense, a more comprehensive questionnaire that accurately addresses the research objectives can be realised. Subsequently, data garnered from the questionnaire were analysed for their statistical inferences using IBM Statistical Package for the Social Science (SPSS) version 22.0 software and the computed results are discussed rigorously.

FINDINGS AND DISCUSSIONS

The targeted contractors received 331 questionnaires, with respondents including project managers, site managers, quantity surveyors, project engineers, and architects, among others. Three hundred and four questionnaires were successfully returned by respondents, representing a response rate of 31,4 percent. Using self-administered questionnaires, an acceptable response rate ranges from 25 to 35 percent. Therefore, the total number of responses received is sufficient for this study.

Cronbach's Alpha (α) is then used to determine the level of reliability since all 30 questionnaire items were included to test the reliability of the variables. If is less than 0.6, the reliability is deemed flawed. If it falls between 0.6 and 0.7, the reliability is considered adequate. However, between 0.7 and 0.8, the reliability is good, and between 0.8 and 0.95, the reliability is exceptional.

The analysis of the variables relating to the use of BIM for controlling cost overruns in construction projects yielded a value of 0.833, indicating a very high level of reliability.

BIM Can Intercept Causes of Cost Overrun

On the causes of cost overrun in construction projects that BIM can intercept, the resulting mean value from the computerized data analysis is tabulated in descending order in Table 1. From the results, the highest ranking has a mean value of 4.65, while the lowest ranking has a mean value of 3.5, with a difference mean score value of 1.15. This ranking provides an

indication of which causes of cost overrun in construction projects BIM can intercept successfully.

Table 1. Causes of Cost Overrun that can be Intercepted by BIM

Cause	Mean	Rank
Inaccurate quantity take-off for the project.	4.65	1
Amendments toward standard drawings during the construction stage.	4.38	2
Fluctuations in material prices.	4.35	3
Lack of communication between parties.	4.35	4
Inadequate resource plan.	4.34	5
Slow information flow between parties.	4.32	6
Project team slow rate in making decisions.	4.22	7
Deficient estimation of cost.	4.13	8
Poor project management.	3.95	9
Changes in scope by the project sponsors.	3.5	10
Average Mean	4.22	

The highest ranked cause of cost overrun in construction project that BIM can intercept is inaccurate quantity take-off for the project from the analysed results. A previous study also supported this finding Patil and Khandare (2017), where most inaccurate quantity information was produced manually from 2D drawings. The consequences of manual taking-off can be linked to the high probability of mistakes arising from typing or formula errors. This drawback can now be mitigated by adopting BIM in which quantities are automatically extracted from a 3D model and then extrapolated for accurate cost estimation.

The next cause of cost overrun in a construction project that BIM can intercept is amendments toward a standard drawing during the construction stages. Most contractors agreed that when BIM is adopted, modifications toward drawings during the construction stage can be minimized, and therefore cost overrun can also be effectively avoided. This result was equally supported by those who mentioned that BIM not only provides 3D visualization but also quantifies material quantities (Rajendran, Seow, & Goh, 2013). Any design clashes can be detected before the start of construction activities, leading to significantly less costly rework. Subsequently, the third variable of cost overrun that BIM can intercept has to do with fluctuations in the prices of construction materials. This factor can be attributed to various reasons, such as the monopoly of suppliers or the unavailability of construction materials locally (Aziz, Memon, Rahman, & Karim, 2013). However, embedding information on materials and suppliers into the 3D building model before construction can expedite procurement processes, and costly delays can be prevented.

Similarly, most respondents agreed that BIM adoption in a construction project could improve communication among the various parties involved. In this regard, Zuhairi, Marshall-Ponting, Ahmed, Nasly, & Zahrizan (2014) demonstrated in their research that BIM could offer significant benefits to the Malaysian construction industry, especially in enhancing the communication between different parties in construction projects. In this regard, BIM aids in streamlining clear communication between clients, consultants, and contractors in construction projects by providing a single respiratory system for exchanging digital information in one or more agreed formats.

Next, a preliminary resource plan was also highlighted as one of the causes of cost overrun in construction projects intercepted by BIM. This factor enforces the importance of having a detailed resources plan, an area on which BIM can have a significant impact. Similar to the aspect of fluctuation in materials prices as described above, information on resources for each construction activity – workforce, materials, and machinery – should be integrated rigorously into the building information model so that procurement and construction activities can be performed seamlessly, reducing the risk of delays and cost overruns. Goh, Goh, Toh, & Ang (2014) highlighted that resource planning could easily be carried out because desktop computers are becoming increasingly more powerful these days to support BIM-enabled applications.

BIM can prevent cost overruns in building projects caused by factors including delayed information exchange between parties and the project team's slow rate of decision-making. The conventional belief is that a slow information flow will result in a slow decision-making process. To this aim, BIM can assist in mitigating some of the most significant issues in construction, particularly those associated with small projects, by facilitating a shared understanding across stakeholders situated in separate places but working on the same remote construction project. A previous study shows that BIM provides project stakeholders with a higher degree of information in the early stages of the project to better inform decisions before field implementation (Li, Zheng, Si, & Xu, 2019).

Similarly, cost overruns in building projects resulting from inadequate cost estimation can be controlled by applying BIM, as most respondents to this study agreed. Numerous studies have demonstrated that BIM is advantageous because it provides an exact cost estimate, saves time, exhibits minimal design coordination errors, and provides energy-efficient design solutions for consumers (Li et al., 2019). In addition, BIM can depict the whole building life cycle, including construction, operation, and maintenance. Quantities and shared properties of materials and other resources can be extracted with a high degree of precision in real-time, while other features of the BIM applications can be used to isolate and define distinct work scopes (Elmualim & Gilder, 2014). Finally, poor project management and changes in scope by the project sponsors were ranked as the two least significant causes of cost overrun in construction projects where BIM can intercept. The whole dimension of project management requires significantly more knowledge and skills than BIM application alone, and BIM is part of the myriad of supporting tools. Also, project sponsors may require changes in project scope from time to time, but this does not happen frequently. However, the putative benefits of BIM in supporting change management and overall project management are still palpable in every aspect. It was found that major public and private infrastructure projects that suffered poor planning and management could still achieve commendable successes when BIM was introduced (Btoush & Harun, 2017).

Overall, the findings of this section provided a positive explication that Malaysian contractors could reduce cost overrun in construction projects by implementing BIM.

Current Practices of Cost Overrun Control in Construction Projects

The current practises for controlling cost overruns in construction projects are presented in descending order of mean value in Table 2. The highest-ranking item has a mean score of 4.55, while the lowest-ranking item has a mean score of 4.38, with only a 0.17 difference in

mean scores. This result indicates that all the aforementioned factors are commonly utilised to prevent construction project cost overruns.

Table 2. Current Practices of Cost Overrun Control in Construction Projects

Practices	Mean	Rank
Proper project planning and scheduling	4.55	1
Comprehensive contract administration	4.55	2
Use of experienced subcontractors and suppliers	4.52	3
Setting up stores for required construction materials	4.50	4
Frequent progress meeting	4.48	5
Planning the schedules for material delivery process	4.48	6
Monitoring the quality of work in various activities continuously	4.46	7
Using proper methods for construction	4.43	8
Effective site management and supervision	4.41	9
Doing cost estimations before starting project	4.38	10
Average Means	4.48	

Most of the respondents agreed that the project cost can be more easily kept in check with a proper project plan and schedule. The task of planning a project rigorously is of utmost importance for a project manager. In this regard, a comprehensive resource-loaded schedule provides a detailed sequential plan for all the key personnel in carrying out their duties accordingly. The adage "if you fail to plan, you're planning to fail" never diverges from its fundamental principle in this context.

Also, respondents agreed that implementing a comprehensive contract administration helped mitigate cost overruns in construction projects. In this instance, the Quantity Surveyor (QS) plays a crucial role in ensuring that the contract is administered impeccably; hence, a QS should be competent in his duties. However, competency is fruitless without integrity at its core, as QS deals significantly with financial resources, and decent decisions could sometimes be compromised when money is involved.

The following practice of controlling cost overrun in construction projects deals with the appointment of experienced subcontractors and suppliers. The finding shows that most of the contractors at Kuala Lumpur prefer to appoint experienced subcontractors and suppliers, which similarly has been recommended by previous research that suggest selecting partners who possess sufficient experience and a good reputation in similar nature of work will help to mitigate the risk cost overrun in construction projects (Zuhairi et al., 2014; Goh et al., 2014). The inherent confidence of the clients can be elevated when an appointed construction team holds a certain level of commendable reputation among their peers.

Furthermore, it has been highly agreed that setting up stores for required construction materials helps in reducing cost overrun in construction projects. This is supported by previous research where it was found that by having their storage for construction materials, contractors can plan better for their activities' resource allocation, and this will help them alleviate the risk of materials shortage which could lead to expensive delays (Enshassi, Al-Najjar, & Kumaraswamy, 2009). Concurrently, the practice of conducting frequent progress meeting also helped in controlling cost overrun in construction projects, as any underlying issues on site can be promptly brought to the meeting table for discussion and possible solutions brainstormed and agreed upon before they exacerbate.

Besides, the respondents also answered positively about planning the time schedules for the material delivery process. Materials availability and supply chain management is paramount to the implementation of construction activities on site. In this regard, this practice indicates that proper resource planning can prevent costly delays, in which a detailed delivery schedule will significantly improve the speed and efficacy of the whole procurement process.

Additionally, most contractors' continuous monitoring of work quality is highly practised as a measure of controlling cost overrun. This is an effective preventive measure as any rework for activities below-par is undoubtedly time and cost consuming. This measure has been highlighted in the study where constant monitoring of construction activities resulted in a high level of early error detection, and thus appropriate actions can be taken without further delay to avoid cost overrun (Danso & Antwi, 2012). In the same way, adopting proper construction methods is also highly regarded as a measure to control cost overrun in projects. To this end, implementing a systematic control mechanism is part of a proactive organizational strategy to mitigate financial risk in construction projects.

Correspondingly, respondents held high regard for effective site management and supervision to control cost overrun in construction projects. Respondents opined that performing cost estimations before a project commences to control cost overrun is highly practised by the construction players at Kuala Lumpur. By adopting this practice, contractors can monitor the dynamic fluctuation of unit cost in relation to other similar projects, which will help them avoid underestimations during the actual construction phase of the project. This approach has been highlighted in previous research, such as by (Mulenga & Bekker, 2015).

In general, the findings of this section elucidate that the majority of construction stakeholders in Malaysia are currently adopting apposite mitigation measures to control cost overrun in their projects.

Factors of using Building Information Modelling (BIM) to Control Cost Overrun

This final section discusses using BIM as a controlling measure towards cost overrun in the construction project. Table 3 ranked these factors accordingly from the highest to the lowest mean value. The highest-ranked factor is BIM, allowing quantity take-offs and cost estimations to occur early in a project. As BIM generates a 3D model during the design phase, measurements and cost estimations can be extrapolated in real-time into the same model to curate a cost database with high accuracy. This factor recorded the highest mean value of 4.53, which suggested it the strongest indicator of BIM's ability to control cost overrun.

The second-highest ranked factor, registering a mean value of 4.49, is the ability of BIM in helping its clients to visualise the three-dimensional organization of a building, and this visualisation will better inform the clients of what they are expecting from their endeavour.

Next, BIM helps users better to understand the arrangement of construction activities and project period. In this regard, the sequence of each activity and the whole project duration can be represented graphically in a 3D model, leading to a better overall understanding, which will undoubtedly help mitigate project cost overrun. This factor recorded a mean value of 4.48.

Table 3. Factors of using Building Information Modelling (BIM)

Factors	Mean	Rank
BIM allows quantity take-offs and cost estimations to occur early.	4.53	1
BIM helps clients to visualize the three dimensional organization of the building.	4.49	2
BIM helps to understand the arrangement of construction activities and project period.	4.48	3
Efficiencies through the design process are becoming clearer by using BIM.	4.46	4
BIM limits errors due to miscommunication between Architects, Engineers and constructors.	4.46	5
BIM implementation in construction planning reduces work redundancy.	4.45	6
BIM helps to resolve conflicts early in the design stage.	4.43	7
BIM helps a lot in decision making of a client.	4.42	8
BIM technology can be used to enhance construction worker safety.	4.41	9
Using BIM reveals potential problems on the site.	4.28	10
Average Mean	4.44	

Meanwhile, respondents suggested that efficiencies are becoming more precise through the design process when implementing BIM. The fourth-ranked factor with a mean value of 4.46, that attributed to the efficient resource's allocation in the construction activities, including claims and payments, as supported by (El Hawary & Nassar, 2015). The fifth-ranked factor is BIM limiting errors due to miscommunication between architects, engineers and constructors, which registered a mean value of 4.46. Having a standard information and communication platform can reduce the potential design errors engendered by different designers during different design phases. Contractors are also able to seek clarification of designs in a more effective method.

Subsequently, BIM implementation in construction planning reduces work redundancy is ranked sixth with a mean value of 4.45. It is vital as work redundancy causes a delay in schedule and cost overrun in construction projects. It was found that BIM implementation in construction planning had successfully reduced work redundancy, such as the need for readjustment of ductworks which frequently occurs during the construction phase, thus avoiding project delay and cost overrun (Mohd & Latiffi, 2013).

Following that, respondents agreed that BIM helps resolve conflicts early in the design stage, where a mean value of 4.4.3. BIM enables building information to keep up to date with regular constructability analyses, which allows for detecting and resolving conflicts among structural, architectural and services elements. If unattended, these conflicts may escalate into claim disputes, and therefore, the subsequent factor of BIM helping the clients in their decision making is also highly supported with a mean value of 4.4.2. In this regard, real-time information stored in BIM can assist the clients in making sound decisions by resolving conflicts in situations, especially those related to additional financial implications.

Adding on, BIM technology enhances the safety of construction workers with a mean value of 4.41. BIM was found to enhance the safety aspects in design and further facilitates the implementation of safety and health measures during the construction stage. Finally, respondents agreed that BIM helps reveal potential problems on-site that BIM enables the construction process simulation, visualizing how the building shall be constructed day-by-day, and revealing potential problems on-site progressively. This process presented opportunities for the stakeholders to develop creative solutions and improvements to overcome highlighted potential problems. This factor came in last with a mean value of 4.28.

Nonetheless, all factors in this section registered mean values of greater than 4, signifying that the factors of using BIM in controlling cost overrun in construction projects are decidedly imperative and practical.

CONCLUSION

This paper provided evidence demonstrating substantial agreement regarding the causes of cost overruns that BIM can mitigate. In addition, this study has successfully uncovered the practises currently utilised by contractors to control construction project cost overruns. Lastly, the adoption and implementation of BIM technology significantly impact the management of project cost overruns. In conclusion, the compelling force of Industrial Revolution 4.0 necessitates a monumental effort to promote the nationwide adoption of BIM technology by all Malaysian construction industry stakeholders.

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FACTORS AFFECTING SAFETY PRACTICE IN CONSTRUCTION INDUSTRIES IN YEMEN

Ta Wee Seow[1,2], Tareq Yahya[1], Kai Chen Goh[1,2], Sulzakimin Mohamed[1,2], Md Asrul Nasid Masrom[1,2] and Shalini Sanmargaraja[3]
[1]Faculty of Technology Management & Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor, Malaysia.
[2]Centre of Sustainable Infrastructure and Environmental Management (CSIEM), Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Batu Pahat, Johor, Malaysia.
[3]Faculty of Engineering and Green Technology, Universiti Tunku Abdul Rahman, Kampar, Ipoh, Malaysia.

Abstract
A construction project is a key indicator of a country's social and economic situation. Construction projects in Yemen have been the fourth largest employer of labour in the country, employing between 9 and 10% of the working population. However, this industry has safety issues, including accidents ranging from minor trauma to major injuries and death. In this light, the purpose of this research was to identify the current safety practices of construction project sites in Yemen, to identify the factors causing safety issues on construction project sites in Yemen, and to suggest strategies for reducing safety problems on construction project sites in Yemen. The research was carried out in Yemen's Sana'a and Amran. The quantitative research method was used to conduct a questionnaire survey. A total of 122 questionnaires were collected and analysed from a total population of 260 respondents distributed, indicating a response rate of 47 percent. The data was analysed using the Statistical Package for the Social Sciences (SPSS) software. The percentage, frequency, and means score value, as well as the average mean index, were used as analysis methods in this study. There is agreement on current safety practices and the factors that have an impact on these issues. Furthermore, the study discovered that current safety practices on construction project sites in Yemen are deplorable, with the majority of respondents agreeing that there is a significant gap in the implementation of safety practices. According to the data gathered, there is a general lack of understanding about the safety issue. Furthermore, the majority of respondents agreed that cash flow issues were a factor influencing safety issues on construction sites in Yemen. Furthermore, a few recommendations for strategies to overcome construction project site safety problems in Yemen include adopting new and faster techniques for better safety response, providing new methods and techniques for hazards recording, and providing better training for all workers. The findings of this study are hoped to be useful as a reference for the government and construction project stakeholders in improving the quality of safety practices on construction sites in Yemen.

Keywords: *Construction industry; safety practice; Yemen.*

INTRODUCTION

Like in many developing nations, Yemen's construction sector is going through a particularly challenging time. These impediments reduce the effectiveness of the building process and complicate the environment for the growth of construction in the nation. Similar to many developing nations, Yemen's construction sector is facing significant challenges that need major effort to enhance building technology, ways of organising and managing construction, and changes in the law. One of the main sources of employment overall is infrastructure projects (Al-shami, 2015). Due to the high frequency of occupational accidents that resulted in fatal injuries, permanent disabilities, temporary disabilities, and occupational diseases, it has long been regarded as a dangerous occupation. An overwhelming percentage of occupational accidents were reported in the construction sector, according to statistics from throughout the world. Companies will incur direct and indirect costs as a result of workplace

illnesses and accidents, whether they are deadly or not. These losses, nevertheless, may have been avoided with better site management, better training, and improved work practices (Issa, Usama, Farag, Abdelhafez and Ahmed, 2015).

According to Alaghbari and Sultan (2018a) In Yemen only, nearly 500 people died in 2013 because of safety and health issues at the construction site. For this reason, the issues of safety and health are one of the most important issues that should receive the double attention of the government and the construction companies themselves. Lack of sufficient attention to the issues of health and safety in Yemen costs 4% of the annual gross domestic product, according to the data of the Ministry of Works and Roads of Yemen, 18,250 professional accidents were reported, and 168 occupational diseases were reported. Ministry of Works and Roads also indicates that there are 324 workers have died and more than 1400 disabled workers permanently (Alashwal and Al-Sabahi, 2019).

In Yemen, the construction industry is plagued by safety-related accidents that range from mild trauma to massive death and injury. As of 2011, 2.5 million jobs were created in the private sector construction industry workforce, taking account for 45.1% of the total construction workforce. This means that the public sector employs approximately 55 percent of Yemen's construction industry workforce. However, there is a lack of regulatory measures implemented by public authorities in Yemen to guarantee construction safety. Accidents could have been avoided simply by implementing strict adherence to standard safety regulations. This lack of regulation, combined with inadequate safety training, results in a high number of accidents (Issa et al., 2015). Most construction companies do not implement construction safety management systematically. As a result, accidents on the construction site have always been highlighted. Furthermore, according to Social Security Organization (SOCSO) statistics, the construction sector ranks 4th in terms of the number of fatal accident cases (Al-shami, 2015).

According to Ministry of Planning and International Cooperation (2016) Yemen is dealing with a significant risk issue in the construction sector, with accidents at Aden port in January 2015 claiming one life and injuring six employees, as well as destroying the corporation's property, raising many questions about the effectiveness of the safety management's implementation of hazards and risks. The problem of managing risk in Aden port has been a serious concern for investor companies, necessitating strict attention and in-depth research to find solutions. The primary reason for the failure is a lack of awareness regarding to safety in reconstruction project sites among all Yemeni authorities. Besides that, the existed polices and strategies in Aden port Refinery need some modifications (Ministry of Planning and International Cooperation (2016). Because safety incidents appear to dominate the construction industry, it is critical to understand the underlying causes. It is also critical to comprehend why Yemen has so many fatalities despite the fact that safety and health precautions are in place (Dahmas, Li, and Liu, 2019). As a result, the goal of this research is to determine why there are so many accidents in Yemen's construction industry. This dissertation seeks to gain an understanding of the causal factors and challenges associated with implementing a sturdy safety management. Furthermore, the aim of this dissertation is to add to the existing body of knowledge on construction safety and health in Yemen. Therefore, the objective of this paper is (i) to identify the current safety practices in the site of construction project in Yemen; (ii) to evaluate the factor influencing of the

construction project site safety in Yemen and (iii) to suggest a solution strategy for reducing the safety problems of construction project sites in Yemen.

LITERATURE REVIEW

Factors Affecting Improper Safety Management in Construction Industry in Yemen

Personal Protective Equipment (PPE), which is categorized as "Safety Equipment," is also cited as a contributing factor to poor safety practices (Table 1). Furthermore, "low level of awareness of the use of PPE" was mentioned as a possible source of unsafe practices. This was likely discovered after it was discovered that injury victims over reported unskilled employees with lower levels of experience. Inadequate safety practices are also caused by a lack of PPE. According to Mohammed (2014), hardhats are frequently utilized on construction sites, and safety boots are occasionally used. Hi- Viz jackets, on the other hand, are rarely seen on construction sites. Barrier protection masks, earplugs, and safety glasses are still very seldom used on construction sites. Tam et al. investigated the availability of PPE and discovered that the most commonly used definitions of PPE are helmets, hard hats, and eye masks, despite the fact that many employees believe that hard hats are inconvenient for their operations. However, the most common suggestion for preventing critical accidents was to wear PPE and be aware of your surroundings (Alaghbari and Sultan, 2018a).

Table1. Possible Factors of Poor Safety Practices

Safety Equipment	Safety Management	Safety Attitude of Workers	Safety Training	Other
Dislike to wearing PPE by unskilled laborers Unavailability of PPE Low level of awareness on using PPE	Poor safety awareness of project managers Failure to appoint a safety officer	Lack of awareness about site safety and regulations No willingness to follow safety norms	Lack of training facilities Lack of understanding the job	Falls Unsafe behaviour such as Operating without authority, working with moving machinery, Wearing dangling clothes and unsafe lifting Workers under influence of alcohol and drugs

(Source: Dahmas et al., 2019)

Safety Challenges in Construction Site at Yemen

It is working on documenting the level of the construction industry in neighbouring developing countries with the development taking place in the developed countries. As we mentioned earlier, there are challenges in developing countries with a lot of social and political pressures in implementing safety and health on the construction site. (Al-Tabtabai, 2002). In developed countries, we also find that the key structural deficiency is the absence of giant contractors operating adequately in terms of protection and health and the failure to cope with the main safety and health problems on the building site and because of the absence of infrastructure proposals and shifting government policies due to different factors such as social, political and economic factors (Idoro, 2004).

Some studies have shown that these issues have become more serious in recent years in many countries, especially in the Arab countries where the revolutions against regimes took

place in 2011 and since then the government's power over the execution of safety and health is almost non-existent, enabling small and large contractors to operate to enhance their incomes by not spending on health and safety at the construction site (Guldenmund, 2010). In Yemen, which is one of the countries that has reached the critical phase of the absence of appropriate authorities and responsibilities for the construction sector, we find that there is a total lack of protection and health at the construction site where the government has not paid the least attention to this part of the situation, and this leads to an impossibility to do so. It can also be seen that many successful construction management contractors have moved to the country and the expense of improving safety and health-related expertise at the construction site has risen dramatically (Profile, 2013).

Despite the lack of credible statistics reflecting the accident outcomes of construction sites in Yemen over the past 8 years, the accident data reported by the Ministry of Works and Roads shows that there were 3,000 accidents reported, of which 70 were fatal. The average mortality rate between 2012 and 2015 was 22 percent of the cases mentioned earlier. An analysis of 40 contractors in Yemen demonstrates this. 5 deaths per worker and 2 deaths per 100 employees were the highest safety record in 2014. These papers are perceived to be bogged down, whether or not they are compared with other nations. However, these statistics are not a realistic representation of what is happening in the Yemeni construction factories because it records much as mentioned above (Othman, Murad, and Kamarudin, 2014). This is because the degree of protection and health organization and regulation of the construction site's execution of safety and health is very poor in Yemen and this contributes to discouraging officials from documenting accidents that occur during service (Ivanov and Aldeen, 2018). Therefore, (Alaghbari, Al-Sakkaf and Sultan, 2019) Said that the huge gap in health and safety in the construction site in Yemen is in the laws of health and safety imbalance in the country and the result of that we find that all sectors in Yemen are organized.

Safety Protocol in Yemen

According to Sabarish, Dinesh, and Preetha (2016) and Naji and Ali (2018) for different factors, the building sector is key in fuelling the demand for housing. Construction tends to include operations such as demolition, site clearance, and secure disposal of construction waste material in most places. The construction process, however, tends to involve dangerous operations that may include height work, manual handling, lifting, scaffolding, and so on. More or fewer building sites tend to be temporary in nature and change during the construction process. This therefore provides room to jeopardize health and safety practices. With the number of organizations involved in a single construction project at the beginning, it is more complicated and difficult to manage processes in the construction sector. More often, a single construction project has a number of sub-contractors who have their own influence, creating a different culture of decision-making and authority. A more satisfactory safety record will result from a personal and positive relationship. However, when the ratio is too high, which is normally the case, health and safety deficiencies are bound to exist. the nature of construction projects is low level education work force and high subcontracting which basically is the main contributor to poor Health and Safety records within most construction projects (Silva, Warnakulasooriya, and Arachchige, 2015).

Safety and health in construction is managed by Labor Law No. 8 of 1980. Safety and health in the construction sector are provided for by the law. Employers are required by labour

law to protect workers from work-related hazards by providing adequate safety. The provisions of the law specify that the following measures should be followed (Al-Arhabi, 2008).

- Employers are required by law to implement all preventative measures prescribed by the Ministry of Labor and Social Affairs in order to safeguard employees from workplace injuries.
- The employee must utilise the safety equipment that is provided for the designated function and adhere to any employer directives that prevent accidents.
- Employers should display on the construction site comprehensive instruction on Health and Safety and these instructions should be in language understood by the employees.
- Employer should make available first aid kit and should make sure the workplace is clean and ventilated.
- Employers to protect employees from work related hazards by providing appropriate safety. The provisions of the law stipulate that the following measures should be adhered to (Yemen labour law).

Strategies to Reduce a Safety and Health Problems in Construction Site

Managing a project effectively means not only executing it within the specified time and with budgeted funds, but also with optimum safety in addition, it has been stated that "improving safety performance on the construction site is not easy, but by reviewing previous studies, possible methods to improve construction safety have been identified and summarized.

Safety management is the most often suggested method for enhancing construction safety. "Nevertheless, most of the poor building safety causes identified are categorized under "Safety equipment. This indicates that, as stated, safety management can improve organizational performance at the organizational level. In addition, hazard identification is one of the essential steps for safety management at construction sites, as the most unmanageable risks are from unidentified hazards (Fang and Wu 2013; El-Mashaleh, Al-Smad, Hyari, and Rababeh, 2010).

Contractors on construction sites should have an organisational safety policy in place for proper safety management, provide formal safety training to their employees, and to improve site safety, hold daily toolbox safety discussions. Furthermore, they are advised to hold weekly organized project-level safety meetings, to always maintain safety security mechanisms at the workplace, to always provide their workers with PPE, post-safety signs and posters at the workplace, to perform weekly safety checks, to award employees for good behaviour, to tailor employees for their dangerous actions, and to enable employees to use secure equality. Less than 25 % using coercive enforcement mechanisms such as fines, as one of the most successful strategies used on projects to improve safety performance. Identifying root causes of construction hazards and injuries and manipulating suitable precautionary tools and equipment specific to the type of construction project and site condition are the critical attitudes for increasing safety efficiency and decreasing risk. (Vitharana, Silva and Silva 2015). Many strategies lead to improve safety and health performance and minimizing the risk in construction site listed below according to (Charehzehi and Ahankoob, 2012), it

includes (i) safety management; (ii) safety equipment; (iii) worker attitudes on safety and (iv) safety training.

RESEARCH METHODOLOGY

This study uses the quantitative research carried out through a survey in order to identify the current safety and health practices at infrastructure project sites in Yemen and to identify the factor of safety and health problems at infrastructure project sites in Yemen. Date gathering is a systematic procedure for gathering information from multiple sources in order to generate a believable and holistic picture of a specific area of interest, from which outcomes can be assessed. Primary data and secondary data appear to be two types of data collection systems, both of which were collected and used in this study. Primary data for this study is gathered through direct contact with respondents or through surveys conducted in the study area. Secondary data, on the other hand, appears to exist and can be obtained from journal articles, internet information, dissertations, discussed research works, conference proceedings, and books.

Data for this research collected from consultants and contracting companies registered in the Yemeni Association of Consulting Engineers Offices in Yemen (YACE, 2013) who are involved in infrastructure project in Yemen. In addition, data collected also from site staff members who are working in architectural and civil engineering departments in public and private universities. The respondents are including engineers, safety officer, site manager, technical, and project manager who had an experience for more than 5 years in consultancy works in construction projects. The target population included engineers and consultants, who are working in construction firms. These responses represented a wide range of consultants who have been involved in infrastructure projects, as well as experienced engineers worked in medium to large size consultancy works. In this study, questionnaires distributed in Yemen and related to construction companies, where the questionnaire answered by safety officers, project managers, professional engineers and site managers who participated in safety and health management in infrastructure project site. The population of this research are 250 personnel whose involved in infrastructure project in Yemen. The number of sample size suitable for this study are 152 respondents as based on study from I. Naji and Hussein Ali (2018). The questionnaire survey distribution was conducted by using google forms and sent through email, WhatsApp and other communication methods.

There were approximately 250 email questionnaires distributed to the targeted respondents. The researcher was able to retrieve 122 questionnaires from the respondents. This equates to a 48.8 percent response rate. According to (Ivanov and Aldeen, 2018), the normal usable response rate ranges from 25% to 35%. (Revathi, Ezhilmathi, Kumar, Sivaranjani and Devaki, 2017). As a result, the total number of responses received is deemed adequate for the purposes of this study. The questionnaire distributed and returned in this study is shown in Table 2.

Table 2. Questionnaire Distribution and Return

Description	Total
Questionnaire Distributed	250
Questionnaire Returned	122
Percentage (%)	48.8%

Data analysis is a process of assessing and evaluating gathered data using multiple techniques in order to gain valuable information and findings. Multivariable studies characterize quantitative research, particularly non-experimental research. Statistics are used to analyses quantitative data in this study. Many computer packages for quantitative data analysis have been developed; the most widely used in education is the statistical package for the social sciences (SPSS). Histograms and pie charts are two types of graphs.

RESULTS AND DISCUSSION

Background of Respondents

The respondents' background was explained in Table 3. A variety of aspects of the research background were considered, including years of experience, positions, and others. However, only questions about the respondent's demographics that were relevant to the study were asked. Furthermore, for this study, the respondent's background was questioned, as was the organization's position. This survey included 122 respondents, who included project managers, professional civil engineers, site managers, safety officers, and technical experts. Table 6 provides information about the respondent's background. From 122 respondents, 46.3 percent are project engineers, while 26.8 percent are project managers, 13 percent are site managers, 4.9 percent are safety officers, and 8.9 percent are site technical. On the one hand, respondents were chosen based on significant criteria such as position, academic qualification, work experience, type of construction, type of project involved, and age.

Table 3. Background of Respondents

Characteristics	Description	Frequency	Percentage (%)
Position	Project Engineer	57	46.3
	Project Manager	33	26.8
	Site Manager	16	13
	Safety officer	6	4.9
	Technical	11	8.9
Academic Qualification	PHD	1	0.8
	Master's Degree	60	48.8
	Bachelor's Degree	61	49.6
Working Experience	Diploma	1	0.8
	0–5 Years	33	26.8
	5–10 Years	39	31.7
	11–15 Years	48	39
	16–20 years	1	0.8
	> 20 years	0	0
	6 months	1	0.8
	Fresh graduate	1	0.8
Types of Construction	Commercial	78	63.4
	Non-Commercial	39	31.7
	Others	6	4.9
Types of Projects Undertaken by the Firm	Government	15	12.2
	Private	27	22.0
	Private & Government	81	65.9
Age	18–30 Years	44	35.8
	31–40 Years	39	31.7
	40–50 Years	40	32.5

On the other hand, the results show that 48.8 percent of respondents have a master's degree, 49.6 percent have a bachelor's degree, and only 1.6 percent have a PhD or a diploma. In terms of construction project experience, 39 percent of respondents have 11-15 years of experience, 31.7 percent have 5-10 years, and no respondent has more than 20 years of experience. However, 26.8 percent of those polled have 0-5 years of experience. However, the same 0.8 percent of respondents have 16-20, less than 6 month, and recent graduate years of experience. In terms of construction type, the results showed that 63.4 percent of respondents work on commercial projects, 31.7 percent work on non-commercial projects, and 4.9 percent work on other projects. With an estimated percentage of 65.9 percent of the 122 respondents, the majority of the firms have undertaken both private and government projects. Government and private projects are undertaken by 12.2 percent and 22 percent of firms, respectively. Finally, the age of the 122 respondents was found to be 18-30 years, 31-40 years, and 40-50 years, with 35.8 percent, 31.7 percent, and 32.5 percent, respectively.

Construction Project Site Safety Practices

According to the average mean index in Table 4, this means that the score value is in the range of $1.5 \leq$ Average Index ≤ 3.5, which falls under the "disagree" and "neither" category. Among all of the questions asked in this section of the study, the average mean of all answers is 2.42, which falls under the "disagree" category of mean. In other words, the majority of respondents disagree with the given sentences, which leads us to the following conclusions:

The majority of contractors disagree that government oversight is applied at infrastructure project sites in Yemen through legislation, codes, and standards. This casts a negative light on infrastructure projects in Yemen. Then, according to Yemen's safety and health law, contracting companies must monitor employees' safety and provide continuous supervision in order to provide a safe working environment. Ivanov & Aldeen (2018) the law also addresses the conduct of both employees and employers on the job site. These are the most basic laws that any country would like to have, and they are already present in many developing countries, but the problem is that they are not implemented in practice. The government's oversight through legislation, codes, and standards is inadequate.

The second of the safety practices is supervising the implementation of regulatory safety rulings. In fact, based on the data gathered, the majority of contractors disagree that there is Supervising the implementation of regulatory rulings regarding safety that is unused. This conclusion was supported by (Alaghbari, Al-Sakkaf and Sultan, 2019). In another matter, it has been admitted that the Labor Act of construction project sites in Yemen is still being updated. The majority of respondents disagreed or were neither agreeing nor disagreeing that updating the labour act was important because the government did not pay enough attention to the importance of updating the labour act to meet the needs of infrastructure project sites in Yemen.

Furthermore, Ivanov & Aldeen (2018) demonstrates in his research that there are numerous benefits to updating the labour Act, particularly in terms of increasing investment. Furthermore, the findings of Conducting Safety Training and Seminars revealed that the majority of respondents disagreed with this statement infrastructure project sites in Yemen. Infrastructure projects are lacking in conducting safety training and seminars that affect the country's construction industry. Previous research also supported this. Although people are

expected to wait for regular construction safety training periods at some point in the policies, being able to practice safety training abilities on-site would assist production people in implementing the safety policies. Practicing production web site safety education skills on-site will force employees to use these abilities in environments where safety is critical and will ensure they are educated. Workers in the creation industry can easily be injured or killed if they are not properly trained. Training is essential in such environments, where accidents and fatalities are highly likely, and it will keep things like workplace injuries from harming you ethically and economically (Ayessaki and Smallwood, 2018).

The finding about Penalties for construction companies violating the rules in making decisions was the most negatively highlighted. This can be addressed if the government appoints staff to monitor all people involved in infrastructure projects and make early reports about rule violations, which will force the parties to follow safety codes. This was also highlighted in a previous study by (Alaghbari and Sultan 2018b, Adnan, Kumaraswamy and Jomah, 2010).

From the respondent's point of view, providing a permit system for hazardous tasks is very poor, such as Working at heights on a construction site is one of the most dangerous and common causes of accidents. The majority of construction site accidents in Yemen occurred as a result of work in high places, resulting in far too many deaths of construction workers. Despite the fact that everyone in the construction industry is aware of this fact, many contractors and contractors fail to take logical and practical steps to protect the lives of construction workers. According to the researcher (Issa et al., 2015), the majority of incidents on construction sites in Yemen occur due to a lack of interest and caution when working in high places.

Finally, in comparison to previous literature, the safety practices are unsustainable practices carried out on site by contractors, such as discussing and monitoring safety issues at regular meetings between parties. Respondents criticized the implementation of safety policies and guidelines, as well as forcing contractors to appoint a supervisor to coordinate safety on the job site. The findings of this objective are that respondents disagreed that the current safety practices of infrastructure project sites in Yemen are poor and lack applied in infrastructure project sites in Yemen.

Table 4. Construction Project Site Safety Practice

Elements	Mean	Rank
Governmental oversight through legislation, codes and standards.	2.75	1
Supervising the implementation of regulatory rulings regarding health and safety.	2.73	2
Continue updating of labour Act.	2.71	3
Discuss and monitoring safety issue at regular meetings between parties.	2.68	4
Conducting regular and frequent safety reviews.	2.50	5
Force the contractors to appoint supervisor to coordinate safety on the site.	2.45	6
Implement policies and guidelines of safety.	2.30	7
Conducting Safety training and seminars.	2.09	8
Providing a permit system of hazardous tasks.	2.09	9
Penalties for construction companies violating the rules.	1.90	10
Average Mean	2.42	

The Factors Influencing Construction Project Site Safety in *Yemen*

Among all of the factors influencing construction project site in Table 5, the result shows the average mean of all answers is 3.59, which falls under the "Agree" category of mean. In other words, the majority of respondents agree on the given sentences, which leads us to the following conclusions. The majority of respondent agree that financial issues, such as claim payment delays, are acceptable. Problems with cash flow. In addition, the problem of cash flow has a significant impact on the safety construction project sites in Yemen. Which is supported by prior research such as Wa Alaghbari & Sultan (2018a). These causes, which have a significant impact and cause construction project delays, included eight managerial causes and four financial causes.

Table 5. Ranking for Factors Influencing Construction Project Site Safety in Yemen

Factors	Mean	Rank
Problems with cash flow.	4.45	1
There was no safety briefing/toolbox meeting.	4.25	2
Noncompliance with environmental laws and regulations.	4.05	3
Delay in project approval and authorization.	3.76	4
inadequate training in operating high-powered machines	3.76	5
There is a lack of understanding about the use of personal protective equipment (PPE).	3.66	6
On-site safety and supervision are inadequate.	3.46	7
Inadequate understanding of the scope of work	3.37	8
Project managers have a low level of safety awareness.	2.95	9
Communication problems.	2.23	10
Average Mean	3.59	

The following factor is related to management issues. It is unfortunate that the majority of respondents answered positively about management issues such as project managers' lack of safety awareness. Failure to appoint a safety officer, inability of monitoring site due to a lack of background, and inadequate site supervision According to Wael Alaghbari et al. (2019), the management factor continues to have a significant impact on the safety of infrastructure project sites in Yemen, despite the fact that supervision and management are currently at a high level.

The third finding points to factors related to construction activities, such as poor site safety and supervision. The findings show that most contractors on site must choose an adequate staff and site supervision efficiency because the work on the site is still poor. Previous studies emphasized the importance of the factor that is related to adequate staff and site efficiency (Ivanov and Aldeen, 2018). In addition, the current study reveals the most unexpected outcome in terms of factors related to socio-political issues "(Crises, Armed conflict, Demonstrations)". Delay in project approval and permission.is considered one of the most issues that influence safety issue. according to Issa et al. (2015) The political situation in Yemen has a significant impact on the construction industry. Finally, when compared to previous literature, every factor mentioned has an impact on safety, whether it is a large impact or a minor influence, such as communication between parties, which is considered the least impacted factor.

Strategy for Reducing the Safety Problems of Construction Project Sites in Yemen

Table 6 show possible strategies for reducing the safety problems at construction project sites in Yemen are discussed in order to achieve the study's third goal. Based on verified literature, a group of professional past studies were selected to be examined by the study's respondents.

Table 6. Strategies to Reduce Construction Project Site Safety in Yemen

Strategies	Mean	Rank
Adopt new, faster techniques to improve safety and health response.	4.66	1
Provide new methods and techniques for recording hazards.	4.57	2
Keep improving training for all employees.	4.53	3
International experts should be provided.	4.46	4
Inspect safety on a weekly basis.	4.39	5
BIM technology has the potential to improve construction worker safety.	4.20	6
Increases capital allocated to safety procedures.	4.11	7
Average Mean	4.41	

Adopt new and faster techniques for better safety response was the first strategy in this section. Many professionals in and out of the Yemen construction industry, including Messner, have emphasized this point 2014, who comment the techniques and technology that are used in the site do not exist and if they do exist, they are very old and traditional, adopting new techniques will undoubtedly lead to bringing attention to the safety and health issue, new techniques will be simple to use, and this will encourage all parties to be concerned about safety (Al-Tabtabai, 2002).

Furthermore, the acceptance rate of these strategies of Provide better training for all workers is the highest at 4.53. The Provide international expert's strategy has a rate mean of 4.46. This discovery was supported by previous research by (Balgheeth, 2016). Meanwhile, with a mean of 4.39, the strategy of Conduct weekly safety and health inspection is ranked fifth. The sixth highlighted point with a mean of 4.20 is how BIM technology strategy helps to reduce the safety and health problems of infrastructure project sites in Yemen. The strategy of increasing capital for safety and health procedures and implementing total safety management in construction companies ranks seventh and eighth, with an accepted mean of 4.11.

CONCLUSION

As the conclusion, based on the results obtained, the following suggestions available for a possible strategy for attempting to control safety performance in the future of the Yemen's construction sites;

a. Because Yemen is a developing country, it is critical to care for and invest in young people because they make up a large percentage of the workforce's potential. Investing in people by improving their skills and abilities will lead to better job performance. Government and authorities should focus on technical education and training programmers.

b. The construction project must be improved and supplied through the use of new technologies and international experts.
c. The government should focus on labor-intensive management or human resources as these could be the key to a safe and successful construction project.
d. It is suggested that the government invest in the local building materials industry and encourage research into the use of materials and methods for developing them.
e. It is critical for the Yemeni government to work toward comprehensive administrative and human resource development. It is also important to promote the function of effective labour and human resource management, as this could lead to the successful management of construction projects and initiatives.
f. In construction projects, management skills must be improved through training, seminars, and programming in order for the workforce to adapt to the strategies/policies required to reduce the impact of mistakes on safety.

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WORK STRESS AND TECHNOLOGY ABSORPTIVE CAPACITY AMONG SMALL AND MEDIUM-SIZED ENTERPRISE IN CONSTRUCTION INDUSTRY

Aina Mardia Sallehuddin[1], Roshartini Omar[2,3] and Norliana Sarpin[2,3]
[1]Naza Engineering Construction Sdn. Bhd. Jalan Judo 13/45, Seksyen 13, Shah Alam, Selangor, Malaysia.
[2]Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor, Malaysia.
[3]Centre of Sustainable Infrastructure and Environment Management (CSIEM), Fakulti PengurusanTeknologi & Perniagaan, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor, Malaysia.

Abstract
Technology adoption is proven to lead work stress in the industry as it involves new requirement and surrounding especially on the beginning stage. Technology adoption in the industry especially among SMEs is seemed impossible as there are several complex technical, cultural and socio-economic factors also became factors that technology adoption not always been successful and made technology absorptive capacity (TACAP) barely happened. However, previous researches highlight the positive effect of control of work stress towards the organisation through high motivation level, activation and excellent mental health enhance continues learning and improvement in the organisation. Meanwhile, TACAP is known as a learning process too. Hence this research would like to explore the relationship between work stress and TACAP among SMEs in construction project. Work stress level and TACAP level among SMEs was measured in the research. Data collected from G3 and G5 contractors within Malaysia the 196 through questionnaires with rate respondent of 56%. Statistical Package for Social Science (SPSS) and Partial Least Squares Structural Equation Modelling (PLS-SEM) was used for data analysis. Based on gathered data, researcher concludes that SMEs in the construction industry experienced medium level of work stress. SMEs in construction in Malaysia also found to have a high level of TACAP for each dimension if the measurement is not solely focused on financial investment, technology pattern and R&D department. The finding also showed that work stress does have a positive relationship on TACAP among local SMEs in construction industry. In addition, each of work stress level has a positive relationship towards each dimension of TACAP dimension. This research aims to enhance technology adoption and improve TACAP among SMEs in construction industry.

Keywords: *Technology adoption; technology absorptive capacity; work stress; construction industry; small and medium sized enterprises.*

INTRODUCTION

The construction industry is one of the dominant sectors that contribute great income to sustain and improve the national economy (Lee, 2016). Construction industry is considered as a significant contributor towards the development of both developed and developing nations as the industry plays a prominent role in providing necessary public utilities and private physical structures (Wibowo, 2014). According to the Board of Engineer Malaysia, BEM (2017), the construction industry remains one of the fastest-growing economic sectors amidst the economy's general slowdown. President of BEM had supported this statement stated that the 260 billion development expenditure under the 11th Malaysian Plan bodes well for the construction industry's growth (BEM, 2017). Whereas Gunto and Alias (2013) outline, the drive of most economies towards industrial development depends on the development of small and medium-sized enterprises (SMEs) as 97% of the industry had been conquered by SMEs.

Construction industry is known as a high demand industry (Bowen et al., 2014). The demands for construction are hike form days to days with all vary and challenging client sophisticated demands and involves technology usage arise the work stress among the players (Barnett et al., 2011). According to Omar and Sallehuddin (2018), the tense surrounding factors that lead to work stress in the industry such as complicated conflict of work, multi-backgrounds of construction projects, communication issues and unrealistic demands from the client are considered the main drivers' rapid change and demand increment happened in the construction industry. Recent studies also mentioned that technology usage in the industry also creates work stress issue (Hueng, 2016). Technology adoption in construction industry is associated with complex modification of the construction process, different workloads, project pace and unrealistic demand from clients due to technology availability, especially within the construction phase (Ibem et al., 2011).

Moreover, Construction Industry Development Board (CIDB) urges technology usage within the industry especially among SMEs in Malaysia's construction industry and made technology absorptive capacity (TACAP) is a crucial element in organisation (Gray, 2006). TACAP may define as an ability to acquire, assimilate, transform and exploit external sources of knowledge and technology for organisation to survive, grow and compete in the market (Omar et al., 2019). TACAP is an important part of technology adoption as SMEs with high TACAP level able to learn and apply technology in the workplace (Lee, 2016). However, the construction industry is known as one of the slowest industries in technology adoption (Lagunes et al., 2016). Omar et al. (2019) opine that most construction players are too busy to push the project dateline rather than trying to learn about new technology, which becomes one of the reasons for failures in technology adoption in the construction industry.

However, there is no previous research that explores the scenario of work stress and TACAP in technology adoption among construction SMEs. Both aspects usually discuss in the separate research area and the literature review of TACAP among SMEs in construction industry is not much established. Hence this research would like to investigate the scenario of work stress and TACAP in technology adoption among construction SMEs. Work stress level and TACAP level among SMEs also will be measure in the research. This research also considered exploring the relationship of work stress and TACAP in technology adoption among construction SMEs. SMEs is identified as the best medium to introduce technology as the construction industry are conquers by SMEs with approximately more than 90% of registered companies (CIDB, 2011).

LITERATURE REVIEW

Work Stress in Construction Industry

There is no one universally accepted definition of work stress (Brickford, 2005). Work stress can have been defined differently as different research areas had a different level of understanding of work stress (Dewe et al., 2012) The National Institute for Occupational Health and Safety, NIOSH (2015) define work-related stress as the harmful physical and emotional responses that occur when the requirements of the job do not match the capabilities, resources, or needs of the worker. Work stress is known as the reaction people in term of strain, a state of negative emotions, and arousal experienced due to excessive pressures or other demands placed on them (Bowen et al., 2014).

According to Omar and Sallehuddin (2018), four main factors drive towards work stress in the sector which are organisational factors, work demand, job role and physical factors which the triggering factors may vary from one to another. However, recent studies show that the urges of technology adoption may create tense and arise work stress level at the workplace too (Tarafdar et al., 2007; Harrison & Lucassen, 2019). Technology adoption and usage usually associate with performance in many different levels as the technology used will alter the workload and work pace, work schedule, career security factors, role in the organisation, interpersonal relations, and job content and design and lead to work stress issue (Tarafdar et al., 2013). According to Salanova et al. (2013), technology adoption may create tense especially during introduction and operation phase in manufacture sectors. However, there is no previous research focusing on stress in technology usage in the construction industry.

In general, work stress in construction usually industry associate with project delay, work ethic issue and accidence at the workplace. According to the Department of Safety and Health Malaysia (DOSH), the construction industry is ranked as the highest number that contributes to death in workplace compared to other sectors (DOSH, 2019). Despite all negative site, work stress also is proven beneficial towards performance too (Karasek, 1979; Joels et al., 2006 Leung et al., 2011). Previous studies show that controlled work stress can be act as a performance booster and enhance learning performance too (Yerkes and Dodson,1908; Siddi,2006; Chen et al., 2009). Lueng et al. (2011) mention that well-managed work stress made the personnel to be creativity and enthusiasm which enhance performance improvement.

Work Stress Level

Work stress being measures in many ways as the classification of work stress level also being made in different manners. Leung et al. (2011) classified work stress in the construction sector into three categories; job strain, psychological stress and burnout. Ibem et al. (2011) classified work stress into three stages; low stage, medium stage and high stage. Meanwhile, Enshassi et al. (2015) classified work stress into; behavioural, psychological stress, physical stress and emotionally. In this research, research refers to General Adaption Syndrome by Selye (1950).

The General Adaption Syndrome (GAS) highlight work stress can be classified into three stages alarm, resistance and exhaustion stage as shown in Figure 1. The GAS model also highlights that work stress can be in positive and negative stress (Dopkeen & Dubois, 2014). Meanwhile, Yerkes and Dodson (1908) show that each phase of work stress may lead to performance in the Inverted U model as shown in Figure 2. Alarm stage is known as low stage of work stress (Ibem et al., 2011). At this stage, work stress may create performance trigger (Dewe et al., 2012). Karasek (1979) also prove that this stage of stress may create health tension and driven to increase motivation level. During this stage, daily emotion can be the measurement to measure the level of stress (Brickford, 2005; Leung et al., 2011 Maslach & Leiter, 2014).

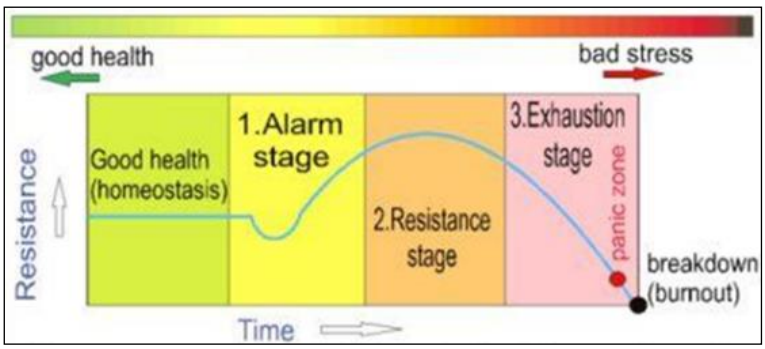

Figure 1. General Adaption Syndrome (Selye, 1908)

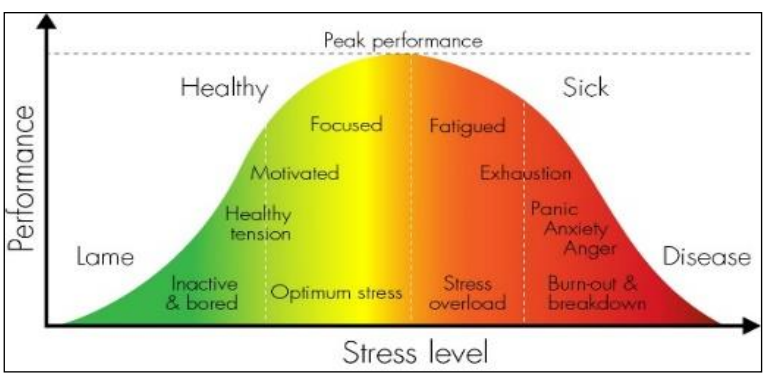

Figure 2. The Inverted U Model Stress and Performance (Yerkes and Dodson, 1908)

Resistance phase is also known as a medium level of stress (Lingard et al., 2012). Based on stress curve by Selye (1950), this stage will start with positive stress and accumulation of work stress will start to bring toward performance deterioration on the next phase (Yerkes and Dodson, 1908; Siddi, 2006). According to Camison & Forbes (2010), this stage is known as the peak performance stage where personnel tend to be highly motivated, focus and devoted towards their work. According to Siddi (2006), the low and medium level of stress stimulate "glucocorticoid" hormone with enhancing learning and memorisation formation. However, if the accumulation of work stress at this phase happens in a long period, good stress will be transmitted to bad stress or known as distress (Dopkeen & Dubois, 2014). During this moment, physical stress will start to spark and personnel tend to withdrawal from contact with others (Brickford, 2005; Leung et al., 2011 Maslach & Leiter, 2014).

Continues accumulation of distress for a long period will enhance to exhaustion stage where the burnout will happen (Schwabe et al., 2012). Burnout is happened due to prolong of exposed stress from the workplace (Maslach & Leiter, 2014). At this stage all, distress will take cover through the whole level by creating a deeper impact on career, family life and personal wellbeing (Dewe et al., 2012; Schwabe et al., 2012). This phase associates with increased levels of employee absenteeism and turnover, decreased levels of productivity, as well as lost workdays due to disability or sick leave (Chen et al., 2009). As per discuss shows work stress is proven to affect performance in both ways; negative and positive. Hence, it is also possible that work stress also may be capable to enhance TACAP for better technology adoption. In this research, daily emotion, social relation and personal achievement will be used to measure the work stress level in the construction industry.

Work Stress in Technology Adoption in the Construction Industry

Technology is an important aspect within the working dimension as technology is proven beneficial to humans and the business market (Bakar & Tufail, 2012). Nowadays all sectors from both developed and developing countries are urged to emphasise their own company's technology establishment in sectors to ensure the organisational continuous survival, profit-making, efficiency and competitive advantages (Omar et al., 2019). Technology is also proven to positively enhance organisation performance from many aspects (Chauvet, 2015). Hence, such phenomena have no exemption for Malaysia's construction industry too. Nowadays, the government encourages technology usage especially among Small and Medium-sized Enterprises (SMEs) as 90% of the industry are constituted by them (Gunto & Alias, 2013). Technology acceptance among SMEs bring technology acceptance within the industry (Kamal & Flanagan, 2012).

Technology usage in the construction industry usually related to a safe and clean construction site, lack of construction wastage, lack rely on the workforce, sustainability, reduce numbers of the accident, promotes efficiency and productivity (Hueng, 2016). Technology has also proven to help deliver projects with high project quality on a specific time frame and promote sustainability within the industry (Barret & Sexton, 2006: Hueng, 2016). However, recent studies show that technology adoption and implementation may lead to work stress at the workplace (Barret et al., 2011). This issue arises due to technology adoption usually associate with the additional workload, job complexity, job replacement, struggle to adopt new technology and continues to upgrade and learning due to technology short time trend (Tarafdar et al., 2013).

This type of stress is known as technostress. Technostress refers to a modern disease of adoption caused by an inability to cope with new technology (Sami & Pagannaiah, 2006). Technology adoption in the construction industry also leads to complex modification of the construction process, different workloads, project pace and unrealistic demand from clients. Furthermore, clients also frequently ask for changes especially within the construction phase due to technology availability. On the other hand, the construction industry is also known as one of the slowest sectors in technology usage compared to another sector (Kamal & Flanagan, 2012). This happens as most of the construction workforce is too busy pushing project delivery dateline rather than explores and learn new technology in the industry (Omar et al., 2019). Such issues lead to a low level of TACAP among the construction players in Malaysia's industry.

TACAP is an important aspect of technology usage. The higher level of TACAP made technology usage successful in the organisation. TACAP may define as an ability to acquire, assimilate, transform and exploit external sources of knowledge and technology for organisations to survive, grow and compete in the market (Omar, 2012). Previous research highlighted that TACAP is known as a learning process conducted within an organisation through different stages (Gray, 2006; Flatten et al., 2011; Chauvet 2015). TACAP bring direct impacts toward organisation's performance as the learning aspect is driven towards improvement, innovation and competitive advantages (Chauvet, 2015). Whereas work stress is also related to organisation's performance usually involved with learning within an organisation.

There are several strong models used in work stress research area that related to learning performance including the Inverted U model (1908) and JDCs model (1979). The Inverted U model (1908) highlighted performance can be improved between the low and high level of stress in the best performance. The model also claims that too high work stress leads to performance deterioration, whereas no work stress leads to boredom and low self-esteem. In the JDCs model highlighted the workplaces aspect that leads to effective learning in an organisation through job demand, job control and social support aspects. This research highlights that workplace aspects can be work stress trigger and learning enhancer at the same time.

Based on the literature review discussed above, researcher found there is a possibility work stress and TACAP relationship as work stress had an established connection on learning ability whereas TACAP is a learning process. However, since these topics have never been discussed and there is no redundancy on work stress and TACAP within the construction industry in previous research. Therefore, researcher would like to explore a new research dimension on the scenario of work and TACAP among SMEs in the construction project.

Technology Absorptive Capacity among SMEs in Construction Industry

Competitive global environments within construction industry nowadays demand the usage of technology and skills which made TACAP as important aspect towards the organisation (Bilau et al., 2015). TACAP also known as firm's overall capacity for learning, implementing new knowledge, disseminating new knowledge internally and making use of new resources, including new technologies through tacit and explicit knowledge (Gray, 2006). TACAP is considered an important weapon for any kind of organisation as it allows the firm to create its competitive advantages for survival purposed (Wibowo, 2014). TACAP also beneficial towards firms in so many ways as TACAP may increase employee performance and communication skill, enhance productivity and efficiency which will result in performance growth (Gunto & Alias, 2013). Hence it is important to enhance TACAP especially among SMEs in construction industry to bring improvement towards the industry.

SMEs are considered as the best medium to introduce technology as construction industry is conquers by SMEs (CIDB, 2011). According to Thawala et al. (2012), SMEs in construction industry plays two big roles as general contractors for small and medium-sized projects and as sub-contractors to large construction companies for large projects. SME also has been a source of economic development through its vast creation of employment, wealth creation and innovation by introducing competitive strategies which set them apart from other firms (Gunto & Alias, 2013). The driver of most economies towards industrial development is dependent on the development of SMEs considering its large numbers and structure which under adequate conditions gives them the flexibility and ability to stand adverse economic situations (Bilau et al., 2015). Hence, that is the strong reasons why SMEs become the best medium to enhance technology usage in the construction industry.

However, recent studies reported that level in of TACAP in construction industry is relatively low comparing to other sectors (Lagunes et al., 2016). Omar et al. (2019) opines that most of the construction player is too busy to push the project dateline rather than trying to learn on new technology which becomes one of the reasons failures in technology adoption in construction industry. In addition, technology adoption is even impossible especially

towards SMEs within the industry due to the abundant number of challenges; human capital, incompetent management, unstable financial issue and lack of opportunity that made technology adoption is challenging which leads to low level of TACAP (Kamal & Flanagan, 2012). Organisation for Economic Co-operation & Development (OCED, 2014) also highlighted misfit skill by universities and technical institution, lack of awareness and alliances and natural disaster is part of the factor that results in low TACAP among SMEs.

Technology Absorptive Capacity Level

Zahra and George (2002) define TACAP as a set of organisation routines and processes, by which firms acquire, assimilate, transform and exploit knowledge to produce a dynamic organisation capability. Zahra and George (2002) also outlined that TACAP consists of four main dimensions which are; acquisition, assimilation, transformation and exploitation. Each dimension plays important roles in technology adoption and may be used to measures the organisation's TACAP level (Camison & Forbes, 2010). Many proxies and aspects that are used to measure each TACAP dimension. However, many researchers argued, the measurement of TACAP are only focused on R&D orientation which is only suitable for huge and strong establish companies with an abundant amount of capital and resources (Flatten et al., 2011; Wales et al., 2012). Since this research focuses on TACAP among SMEs such aspect needs to be eliminated as the SMEs had disabilities in the R&D aspect (Lagunes et al., 2016).

Acquisition is referring to the firm's capacity to identify and acquire knowledge that is externally generated (Gray, 2006). Organisation aspect will be used including organisation routine and motivation to explore the new knowledge (Camision & Forge; 2010; Flatten et al., 2011). Organisation routine and support also had been used in measuring technology in construction industry through organisation support through facilities at the workplace, and motivational aspect in the workplace (Tufail & Bakar, 2012; Kamal & Flanagan, 2014).

Next is assimilation phase which is an ability of organisation to get an in-depth understanding of the new information (Wibowo, 2014). In this phase, researcher used knowledge sharing and understanding internally and externally. Knowledge understanding has been measured through communication within employees and employer and external parties such as; supplier, distributor and manufacturer organisation for new input sources and ideas (Chauvet, 2015).

Transformation is a firm's capability to combine the acquired knowledge with the existing knowledge by adding knowledge, deleting knowledge or interpreting the same knowledge in a different manner (Gray, 2006). The employee ability also been used by considering the ability of employees to improve the product, work method, and problem-solving aspect on this phase (Camison & Forge, 2010; Flatten et al., 2011; Chauvet, 2015). Since researcher is focused on the construction industry, the improvement will be considered on administration and construction site improvement as being opined by Lawrance et al. (2016).

Last dimension of TACAP is exploitation, which is an organisational capability, which based on routines that allow determination, expansion and utilization of existing competencies or create one by combining acquired knowledge and transforming into operations (Bilau et al., 2015). Different research used different variables to measure overall organisation

performance. According to Tufail & Bakar (2012), overall performance can be measured through individually, organisationally and the project itself based on client perception including, client satisfaction and recurring client subscriptions due to the characteristic of SMEs in Malaysia and the rate of technology advancement in the construction industry (Lagunes et al., 2016).

RESEARCH METHODOLOGY

This research is a descriptive orientation and using the questionnaire form as the research instrument. The questionnaire was developed based on a literature review and referred to some available sets of questionnaires used in the previous study: multiple choice and Likert Scale used in the questionnaire. Statistical Package for Social Science (SPSS) and Partial Least Squares Structural Equation Modeling (PLS-SEM) was used for data analysis. There are three parts to the questionnaire; demography, work stress level and TACAP. Before the data collection, the questionnaire will be verified thru several tests to ensure the reliability and validity of questions thru content validity, pilot test and exploratory factor analysis. The data collection will be done once the questionnaire is improved.

This research's research population is the managerial level of construction SMEs G3 and G5 in Penang, Pahang, Selangor and Johor region only. The managers are focused on Penang, Pahang, Selangor, and Johor because they listed the highest number of SMEs in all Peninsular Malaysia regions. The research scope is narrowed by focusing on managers for G3, and G5 classes as both of the contractors, G3 and G5, were also the highest grade in their enterprise-class (CIDB, 2014). Therefore, the unit of analysis for this study-based is the organisation. The researcher determined the number of samples involved in this research refers to Krejie & Morgan (1970) sample study table and stratified sample method. In this research, 351 respondents were involved. However, only 196 questionnaire forms have been obtained to obtain the total number of completed questionnaire forms. This indicates that the response rate in this research is 56 %.

DATA ANALYSIS & FINDINGS

Work Stress Level Among SMEs in Construction Industry

There are three aspects highlighted in the section; daily emotion, social relationship and performance as discussed in the previous literature review. Table 1 summarised all gathered data for the first research objective. In this section, the level of work stress will be discussed into two parts; each stage and overall level of work stress. Based on the findings, researcher found SMEs experience a different level of work stress for each level.

On the medium level of work stress, social support will be highlighted on by gaining 4.78 value of average mean which is considered to bring high impact towards performance. Most of SMEs employer tends to feel easy and cooperative while working with employee or clients with the mean value of 5.39. SMEs employer also tends to feel more sensitive, sensible and aware towards employees or clients' needs and demand while working together with 5.15 value of mean. This shows that social support brings high impact toward SMEs performance as it allows SMEs employer tend to be cooperative and actively participate with employee and client. Somehow, SMEs employer tends to feel the impression that being blamed for some

of their issues and tend to be stressful work in direct contact with people for a long time with 4.91 and 3.65 value of mean.

Table 1. Descriptive Statistic of Work Stress Level

No	Item	Mean	Average Mean	Description
1	**Low Level (Daily emotion)**		**4.05**	**Moderate**
	I feel like my jobs give me inspiration and motivation.	4.03		
	I feel I work too hard in my job every day.	3.73		
	I feel energetic when I get up in the morning and have to face another day at work.	4.89		
	I feel I am at the end of my patience at the end of my workday.	3.56		
2	**Medium Level (Social support)**		**4.78**	**High**
	I feel refreshed when I have been close to my employee or clients at work.	5.39		
	I feel have the impression that my employee or clients make me responsible for some of their problems.	4.91		
	I feel have become more sensitive and sensible to people since I've been working.	5.15		
	I feel stressful to work in direct contact with people.	3.65		
3	**High level (Performance)**		**5.02**	**High**
	I feel I accomplish many worthwhile things in this job.	4.68		
	I feel I am easily able to understand what my employee/clients wanted.	5.20		
	I feel I handle emotional problems very calmly in my work.	4.97		
	I feel that I have a positive influence on employee through my work.	5.14		

The third level focuses on performance and based on gather data most of SMEs employer tends to feel satisfying towards their personal achievement with the average value of 5.02. Most of SMEs employer had abilities to understand their employee or client's requirement with 5.20 value of mean. Most of SMEs employer also tends to spread a positive influence on the employee with 5.14. Emotion control and accomplishment good thing on the workplace is part of SMEs employer achievement with mean value of 4.97 and 4.86. Despite all average mean for each level of work stress, average mean for all level is required to measure the overall of work stress level with SMEs employer in construction as shown Table 2.

Table 2. Total Average Mean for Work Stress Level

Item	Average Mean	Description
Low Level (Daily emotion)	4.05	Moderate
Medium Level (Social support)	4.78	High
High level (Performance)	5.02	High
Total Average Mean for Work Stress Level	4.62	Medium

Technology Absorptive Capacity Level Among SMEs in Construction Industry

Based on Table 3 researcher found that SMEs in construction Malaysia have a high level of TACAP for each dimension as shown at table if the measurement is not solely focused on financial investment, technology pattern and R&D department. On acquisition level, SMEs employer shows positive encouragement to enhance knowledge capture process with the

value of average mean of 5.09. SMEs employer established sharing routine during meeting and providing facilities to allow capturing knowledge process happened within organisation with mean value of 5.47 and 5.22. This number shows that SMEs employer had the desire to implement technology within organisation by showing great effort for acquisition process happen.

Table 3. Descriptive Statistic of Technology Absorptive Capacity Level

No	Item	Mean	Average Mean	Description
1	**Acquisition**		**5.09**	**High**
	I encourage my employees to assess for new information.	4.97		
	I provide facilities such as computer and Wi-Fi to ease new information seeking process.	5.22		
	I send my employees to technical seminars or programmes every year.	4.70		
	I established sharing the latest information routine among my employees during the meeting session.	5.47		
2	**Assimilation**		**5.33**	**High**
	I inform and inform regarding the latest info on technology or machinery by my employees.	5.65		
	I let my employee meet with different contact that involves in project such as manufacture, supplier, contractor or client contact for new information and insight.	5.39		
	I encourage my employee to participate actively during “on-site” training.	4.97		
3	**Transformation**		**5.21**	**High**
	My employee is able to solve problem encounter at the workplace.	5.47		
	My employee able to improve working method become more convenient, time reduce and safe at construction site.	5.42		
	My employee able to share input or idea during meeting session.	4.74		
4	**Exploitation**		**4.84**	**High**
	The dependency of technology and machinery usage can be seen at construction site and office.	5.39		
	My organisation able to deliver project within time frame and meet client requirement.	4.98		
	Some of client used my organisation’s services more than one time.	3.87		
	My organisation looking forward to using more technology in future.	5.15		

On assimilation dimension, SMEs employer shows affirmative support to enhance knowledge understanding and sharing process within the organisation with value of average mean of 5.33. SMEs employer claimed most of organisations have good communication flow and sharing knowledge practice regarding the latest info on technology or machinery with mean value of 5.65. As in further, most of SMEs employer exposed their employee to different contact that involves with the project such as manufacture, supplier, contractor or client to allow learning process happened with mean value of 5.39. Hence, this number shows that SMEs employer enhances knowledge understanding and sharing process within organisation both ways internally among employer-employees and externally thru different contact involvement.

Transformation dimension usually focuses on employees' abilities. Most of SMEs employer reported that their employees are competent towards their job scope with 5.21 value of average mean. SMEs employer claimed that most of their employees have problem solving skill and able to handle small problems encounter during work with 5.47 value of mean. Furthermore, most of SMEs employer agrees that their employee able to improve working method current become more convenient, time reduce and safe at construction site with the average value of 5.42. This number shows that SMEs employees are competent to learn new input regarding the latest technology and machinery available in the market.

Lastly, dimension of TACAP is exploitation. The exploitation level TACAP among SMEs is considered high as most of SMEs claim to have a great performance with 4.84 value of average mean. Moreover, SMEs also shows openness to use technology in construction site as there is a positive dependency of technology and machinery usage can be seen at construction site and office with value of 5.39. Furthermore, most of SMEs employer looking forward to using more technology in future with value of 5.15. Hence, this number shows there is a positive response on technology adoption and active TACAP process happened among SMEs in Malaysia construction industry even there is number of barriers exist in the process. TACAP level among SMEs is quite high if the suitable measurement and approach used as shown in Table 4. Since SMEs have many frictions in technology adoption the approach to adoption used in different manner compares to huge organisation.

Table 4. Total Average Mean for Technology Absorptive Capacity Level

Item	Average Mean	Description
Acquisition	5.09	High
Assimilation	5.33	High
Transformation	5.21	High
Exploitation	4.84	High
Total Average Mean for TACAP Level	5.11	High

Work Stress and Technology Absorptive Capacity Level among SMEs in Construction Industry

The final research objective in this paper is to explore the relationship on work stress and TACAP among SMEs in construction industry. This research used direct hypothesis testing, bootstrapping thru PLS-SEM software. Bootstrapping will result to construct a confidence interval for parameter and also known as direct hypothesis testing where the relationship of research will be revealed (Ramayah et al., 2018). Researcher used 500 numbers of bootstrap subsamples, one-tailed and 0.05 significance level as the direction of latent variables had been determined. Moreover, the direction of latent variable is single direction and single tailed is more suitable.

Based on the Table 6, each level of work stress level shows positive value towards each of TACAP dimension. The diagram with thicker line shows significance relationship in the model. Significant structural model path coefficient can be interpreted relative to one another thru the original sample value (Hair et al., 2017). Path coefficient should be in range of -1 to +1 (Hair et al., 2017). The value of +1 representing strong positive relationship and vice versa. The higher value of path coefficient, the larger impact to endogenous latent variables.

Table 5. Rule of Thumb Path Coefficient (Hair et al., 2017)

	Rule of Thumb
Path Coefficient	*p value < 0.01* *t value > 2.58 (two-tailed)* *t value > 2.33 (one-tailed)*
	p value < 0.05 *t value > 1.96 (two-tailed)* *t value > 1.645 (one-tailed)*
	p value < 0.10 *t value >1.645 (two-tailed)* *t value > 1.28 (one-tailed)*

Table 6. Bootstrapping of Work Stress Level and Technology Absorptive Capacity Level

Hypo	Relationship	Original Sample	Sample Mean	Standard Deviation	T Statistics	P Values	5.00%	95.00%
H1	Low Level -> Acquisition	0.134	0.132	0.061	2.213	0.000	0.044	0.244
H2	Low Level -> Assimilation	0.166	0.177	0.081	3.354	0.040	0.023	0.288
H3	Low Level -> Transformation	0.196	0.196	0.100	1.952	0.051	0.030	0.359
H4	Low Level -> Exploitation	0.171	0.170	0.094	1.823	0.069	-0.002	0.307
H5	Medium Level -> Acquisition	0.152	0.156	0.074	2.069	0.039	0.034	0.277
H6	Medium Level -> Assimilation	0.203	0.201	0.060	2.055	0.001	0.110	0.310
H7	Medium Level -> Transformation	0.179	0.193	0.100	1.795	0.073	0.026	0.345
H8	Medium Level -> Exploitation	0.322	0.330	0.076	4.241	0.000	0.172	0.423
H9	High Level -> Acquisition	0.466	0.461	0.079	5.900	0.000	0.329	0.592
H10	High Level -> Assimilation	0.363	0.351	0.088	4.108	0.000	0.216	0.506
H11	High Level -> Transformation	0.277	0.260	0.095	2.920	0.004	0.138	0.451
H12	High Level -> Exploitation	0.480	0.465	0.072	6.706	0.000	0.371	0.589

Based in the bootstrapping report, the relative importance of exogenous construct in predicting the first dependent construct; acquisition, it is evident that medium level of work stress (ML= 0.152) is the importance predictor followed by low level of work stress (LL= 0.134). Meanwhile high level of work stress (HL=0.466) shows the strong effect on acquisition. This figure also shows that each level of work stress has a positive relationship towards the acquisition dimension. Next, the relative importance of exogenous construct in predicting the second dependent constructs which is assimilation. Based on the table shows that that medium level of work stress (ML= 0.203) is the importance predictor followed by low level of work stress (LL= 0.166). Meanwhile high level of work stress (HL=0.363) shows a strong effect on assimilation. This figure also shows that each level of work stress has a positive relationship towards assimilation dimension.

The relative importance of exogenous construct in predicting the third dependent constructs which is transformation. Based on the table shows that that low level of work stress (LL= 0.196) is the importance predictor followed by medium level of work stress (ML= 0.179). Meanwhile high level of work stress (HL=0.277) shows the strong effect on transformation. This figure also shows that each level of work stress has a positive relationship towards transformation dimension. Lastly, the relative importance of exogenous construct in predicting the fourth dependent constructs which is exploitation. Based on the table shows that that medium level of work stress (ML= 0.322) is the importance predictor

followed by low level of work stress (LL= 0.171). Meanwhile high level of work stress (HL=0.480) shows the strong effect on exploitation. This figure also shows that each level of work stress has a positive relationship towards exploitation dimension.

During bootstrapping, the confidence intervals bias-corrected result of upper and lower bound should also be provided. Confidence interval helps to express the precision and uncertainty associated with the particular sampling method. If 0 does not straddle in between the confidence interval bias result, it means that there is a significant result. As in further, all the hypotheses are determined by significance p-value and t value (T statistics). This research is one tailed with 0.05 significance which refers to rule of thumb: p-value < 0.05, t-value > 1.96 (two-tailed), t-value > 1.65 (one-tailed). Since all the t value is more than 1.645, hence all hypotheses are accepted and significance.

CONCLUSION

Technology is an important aspect within the working dimension as technology is proven beneficial to humans and the business market (Bakar & Tufail, 2012). However recent studies show that technology adoption bring work stress and the current technology level within construction industry is not bright bring challenges in technology implementation within the industry (Salanova et al., 2013; Lagunes et al., 2016; Omar et al., 2019). Such scenario will lead to high work stress level and low TACAP among SMEs in the industry. Hence the aims of this research is to explore the scenario of work stress and TACAP among SMEs in construction industry as both of these topics involved in technology adoption. Work stress level and TACAP level among SMEs in construction will be measured in the research. The relationship of work stress and TACAP also will be explore in this research. The research sample in this research is the managerial level of construction SMEs G3 and G5 in Penang, Pahang, Selangor and Johor region only.

Based on gathered data, researcher can conclude that SMEs employer in the construction industry had a medium level of work stress. SMEs employer also reported having good performance achievement in the moderate level of work stress as most of the employer to experience positive emotion, easy to deal and understands with client and employee demands easily with average mean value of 4.89, 5.39 and 5.20. This result shows that SMEs in construction experience moderate level of work stress and able to bring positive achievement in the organisation. However, this research is opposite to Hong Kong construction industry where; Hong Kong professional experience high work stress and lead to performance deterioration (Leung et al., 2011). Meanwhile, this research result is quite similar to South Africa construction industry where work stress doesn't bring major impact towards work stress level among the SMEs (Ibem et al., 2011). Moreover, the work stress level also considers in eustress type as SMEs in Malaysia seems to be able to handle work stress at the construction industry. Based on The Inverted U model, SMEs work stress level can be in the best area performance (Dewe et al., 2012).

Researcher also found that SMEs in construction Malaysia do have a high level of TACAP for each dimension if the measurement is not solely focused on financial investment, technology pattern and R&D department. In previous research, many arguments stated due to the measurement of TACAP are only focused on R&D orientation which is only suitable for huge and strong establish companies with an abundant amount of capital and resources

(Flatten et al., 2011; Wales et al., 2012). Since this research focuses on TACAP among SMEs such aspect needs to be eliminated as the SMEs had disabilities in the R&D aspect (Lagunes et al., 2016). In this research organisation support, employee ability and overall performance are being used for TACAP measurement. In previous research, most of the research in Malaysia construction establishing literature review regard on TACAP within the industry. Some of the literature reviews emphasise number of items in technology measurement and no measurement on TACAP established in previous research in construction industry. Hence this research constructs TACAP measurement based on the previous research literature review with non-R&D aspects.

Lastly, researcher aims to investigate work stress and TACAP relationship among SMEs in construction industry. This research used direct hypothesis testing; bootstrapping thru PLS-SEM software. Based on gathered data, all the level of work stress are proven to contribute positively towards TACAP dimension. This research highlights that daily emotion, social support and personal performance & achievement bring positive impact toward each dimension of TACAP; acquisition, assimilation, transformation and exploitation. Researcher also found certain pattern in this research which all organisation aspect within TACAP measurement; organisation support for acquisition & assimilation and organisation performance on exploitation show similar effect pattern on work stress aspects; personal achievement, social relationship and daily emotions. In other words, personal achievement brings dominant impact on TACAP dimension, followed by social relationship and daily emotions. Meanwhile, the employee abilities aspect on transformation is being triggered dominantly by personal achievement, daily emotion and social relationship.

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IMPACT OF COVID-19 ON IBS IMPLEMENTATION IN HOUSING CONSTRUCTION PROJECTS

Narimah Kasim[1,2], Rozlin Zainal[1,2], Sharifah Meryam Shareh Musa[1,2], Hamidun Mohd Noh[1,2] and Mohd Faiz Shapiai[3]

[1]Faculty of Technology Management & Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor, Malaysia.

[2]Centre of Excellence for Facilities Management (CeFM), Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Batu Pahat, Johor, Malaysia.

[3]Pejabat KPKR, Tingkat 33, Blok G, Ibu Pejabat JKR Malaysia, Jalan Sultan Salahuddin, Kuala Lumpur, Malaysia.

Abstract

Industrialized Building System (IBS) implementation is one of the best practices to enhance, which contributes to the overall development and economy of the Malaysian construction industry. The advent of COVID-19 has disturbed all aspects of life and the Malaysian construction industry is no different including housing projects. Therefore, the objectives of this study are to examine the impacts and new practice approaches of IBS implementation in the housing construction projects due to the impact of the COVID-19 pandemic. This study conducted the quantitative approach and distributed the questionnaires for data collection. The respondents involved in this study are the G7 contractors in the area of Johor. A number of 140 responses were received and were analysed using SPSS version 22.0. The descriptive analysis was used to describe the respondents' background while the mean, standard deviation, and ranking were used to achieve the objectives of this study. The significant findings showed that the most impacts of the IBS implementation in the housing projects due to COVID-19 were the new safety regulations, improving the supply chain, and reducing the unskilled foreign worker. In addition, the respondents recommend some new practice approaches for IBS implementation including new incentives allocation, up-to-date technology implementation, and skillful workers utilization. In conclusion, this study has been established the impact of COVID-19 through identification of the impacts and suggested new practice approaches, which will help the contractors in managing housing construction projects effectively.

Keywords: *COVID-19; construction project; housing projects; IBS; practice approaches.*

INTRODUCTION

The construction industry plays an influential and essential part in the socio-economy in any country in the world (Yap, Chow, & Shavarebi, 2019). Many projects of industry fail to fulfillment the three elements of success for projects industry, which time, cost, and quality. Many issues are faced in the construction of the housing projects in Malaysia such as delay and excessive cost, and this makes what has been regarded as successful projects need extra cost with terrible arguments and may then be abandoned (Tahir et al., 2019). Besides, the housing projects also encounter critical issues such as the planning approvals being abandoned, delivering the projects are delayed with no compensation payment is considered and conflict has been found among groups (Chai et al., 2015). Industrialized Building System (IBS) has been found the best practice to solve the housing construction project-related issues by many researchers. The IBS application is one of the problem-solving in decreasing the usage of the traditional way detected to the extra site work in nature and construction waste the influenced the time, cost and safety (Ariffin et al., 2018).

According to the Construction Research Institute of Malaysia (CREAM) stated that sufficient components are produced by the local IBS manufacturers for the purpose of

building 25,000 housing units per year (TheSunDaily, 2019). This shortage hinders the ability to produce affordable housing. One of the current problems to implementing the IBS is the lack of knowledge and experience with the skilled workers (Ali et al., 2018). Another issue is the cheap foreign labour that the contractors enjoy and makes it hard for them to transfer modern practices of IBS. The initial cost of IBS implementation is also the problem that interferes in applying the IBS system because the company has to invest a huge amount of capital at the beginning. In addition, government regulations and policies add to the issues of implementing the IBS. Many regulations are imposed that affect the implementation of the IBS system. Training and development of new training centers workshops and specialists are very important to be considered. However, with the COVID-19 pandemic, there are positive and negative impacts of the IBS implementation in the housing construction projects. It is important that academic research is based on recognizing the impacts and analysing their impacts on the industry (Laing, 2020).

The advent of the COVID-19 has complicated the issues of housing construction projects. One of the main problems was the spread of the disease among the workers. Thus, movement control was imposed. Besides, the countries closed their borders. All of these have contributed to the negative impacts of the IBS implementation. However, the pandemic has also affected the construction industry and the IBS implementation in positive impacts. These include the increased use of IBS, the increase in productivity, and usage of IBS components, reducing the unskilled foreign workers, preventing the spread of the COVID-19 among the site workers, and the improvement of safety. Besides, the implementation of the IBS in the housing construction projects involves some challenges due to the COVID-19. These challenges include insufficient knowledge in IBS implementation, government regulation and policies, lack of IBS component suppliers, low cost of unskilled foreign workers as well as health issues. According to this scenario, the determination of the current impact of IBS implementation in housing projects due to COVID-19 will be tremendously crucial. Through this way, the enhancement of IBS implementations in the construction industry in Malaysia is contributed (Baharuddin, 2017). Thus, the study has embarked to fulfill the objectives such as identifying the impacts and new practice approaches of IBS implementation for housing construction projects during COVID-19 pandemic. This study will provide an important base for understanding the impact of COVID-19 on IBS implementation in housing construction projects.

LITERATURE REVIEW

Impacts of COVID-19 on IBS Usage for Housing Projects

IBS has been recognized as an expected way to improve the performance of general construction including cost, quality, safety, reducing waste, and productivity. Khalil et al. (2016) stated that numerous issues that can lead to delay, poor quality, and extended cost have been faced in the management of construction projects of IBS. Furthermore, the ultimate aim fulfillment related to reducing the total cost of construction that will gain minimal wastage, fewer site materials, a cleaner and neater environment, controlled quality and lower total construction costs. Like any other sector, the housing construction industry has been affected by the COVID-19 pandemic disaster. The demand in this sector has decreased because the government is affected and not willing to fund new projects at this specific time. Even the private sector is also affected, and many projects are stopped or delayed due to the motion

control that was imposed by the government. Another issue is the increasing costs of the IBS components because of the rules and regulations imposed by the government that has reduced the production of many sectors like social distancing (The Edge Malaysia, 2020). The following issues are contributing to the overall impacts of the IBS implementation in the housing construction projects.

Safety

The construction industry is globally regarded as one of the most dangerous sectors based on workers, compensation, work-related injury, and fatality rates (Abdullah & Wern, 2011). Till October 2018, the Malaysian construction sector stated that 148 accidents related to the occupation which was the third-highest statistic after manufacturing (1303), and agriculture, forestry, and fishery (289) (Yap et al., 2019). Therefore, construction safety management is essential to ensure safety on project sites (Durdyev et al., 2017). Thus, the implementation of the IBS which is encouraged due to the advent of the COVID-19 pandemic would improve the safety of the workers in the housing project since there will be no more involvement of the workers on the site.

Health

Another positive impact of the IBS implementation in the housing project is its ability to reduce the possibility of infections among the workers. With the use of the IBS, the components are manufactured by the suppliers off-site. In this way, there is not much contact on-site. The use of IBS technology is seen as the best way to reduce the risk of a COVID-19 outbreak in the construction sector (The iProperty, 2020). Thus, IBS implementation in the housing projects has a positive effect in reducing the pandemic spread among the workers.

Productivity

The usage of IBS in a housing construction project is still low. With the advent of the COVID-19, this percentage has increased because the government is encouraging this practice to maintain more sustainability in this industry. Moreover, an extensive definition of productivity quantitatively interconnects between inputs and outputs (Mumin, 2016). Productivity improvement is the main benefit that might be gained through IBS application in construction sites. IBS is able to produce outputs in a fast and efficient way by reducing the dependency on foreign workers. Consequently, it is obvious that IBS implementation is of essential importance in directing instruction projects towards a successful Vision 2020 (The iProperty, 2020).

Dependency on Foreign Workers

One of the issues faced in the Malaysian construction industry is the dependency on foreign workers to construct the projects (Lim, 2016). The method of conventional construction has been used to train construction companies for decades and a lot of foreign workers have been found in Malaysia (Jabar et al., 2018). The pre-fabrication concept in the housing sector can increase the quality of houses, improve the building process and ease the dependency on foreign workers. Thus, with the increased implementation of the IBS in the construction industry, the unskilled foreign workers will be reduced since the IBS

implementation doesn't need many workers like the workers required in traditional construction (Rahim and Qureshi, 2018).

Government Policies and Regulations

Some negative issues happen in the implementation of the IBS in terms of installation. It requires more in terms of installation. There is a need to follow many requirements in terms of installation. Thus, the effect is maybe in terms of time and period. According to The Edge Malaysia (2020), the related government agencies need to play a bigger role in spreading awareness and laying down proper guidelines on finance and cost controls as well as the correct applications of the system. Furthermore, there is also to make buildings correspond with building regulations and certification requirements appropriate for conventional construction increases the cost of using IBS.

Training

The pandemic of COVID-19 has increased the need for applying more percentage of the IBS in the housing projects. However, the need for training and skilled workers cannot be neglected which hinders the application of the IBS in the projects. IBS components are organized strictly and are manufactured through sufficient manufacturing processes, repetitive procedures, and constant quality surveillance (Wuni & Shen, 2019). The iProperty (2020) stated that IBS facilitates the way of development and construction industries in addition to training. There are still not sufficient workers with expertise in the field at the present. Consequently, the government has to learn IBS in the vocational study and produce incentives to improve skills and retrain recent workers for IBS and reduce the dependence on foreign workers in the construction industry.

Initial Cost

IBS application is not an easy task due to much investment and huge capital to buy machines and tools needed for the IBS application in the housing projects (Badaruzzaman, 2008). There is also a necessity to take the high cost of initially setting up factories and buying machines into consideration. The whole supply chain, which has professional workers who have knowledge in design and supervision, will need to be observed to ensure the process is seamless. The initial cost of producing an IBS system is high and cannot be justifiable unless scale economies are realized (Olewi, 2015). Many developers can be engaged to invest in IBS, and this is the first way the government can take; the government, for example, can authorize IBS usage or produce preferred rights to developers who are experienced in undertaking projects widely and with reasonable prices.

Shortage of IBS Suppliers

Other matters need to be tackled before the developers depend on the total implementation of IBS, such as the lack of IBS component suppliers and the sustainability of IBS equipment manufacturers. Fateh et al. (2017) revealed that lack of machinery and supplier is one of the issues the contractors face in the application of the IBS. Thus, the COVID-19 pandemic would make the issue worse since the countries are closing their borders and most of the countries are on movement control to prevent the spread of the pandemic. There is an obvious influence

on on-site activities and project supply chain disruption. Malaysian industry is in an exposed situation since there is a dependency on Chinese industries for parts and materials.

IBS Usage in Housing Projects During COVID-19 Pandemic

This section is devoted to explaining the current practices of the IBS implementation in housing projects. The practices need to be explored to see the difference with the new practices due to COVID-19. What is the new alignment from the current practices for the industry players need to do? IBS construction is gradually increasing in many building projects in Malaysia and the projects have involved modern, contemporary and innovative design for construction (Ismail, Abdul Rahim, & Ghazaly, 2020). The current IBS systems used in Malaysia housing projects are large panel systems, steel frames, precast frames and formwork systems. However, there are difficulties in implementing these systems due to the COVID-19. One of the main points is that the industry in Malaysia is vulnerable as there is a heavy reliance on factories in China for parts and materials. Besides, the contractors are not able to use the previous approaches in transforming the IBS components. Thus, one of the main objectives of this study was to study the approach of the practice in IBS implementation for housing projects due to COVID-19.

RESEARCH METHODOLOGY

This research was quantitative in nature. A questionnaire was distributed among the construction contractors that are registered under the G7 in Johor. In this study, the unit of analysis is individuals such as site supervisor, project manager, project engineer, and etc. who are involved in G7 contractors at Johor Bahru, Johor. The data was collected and then analyzed using SPSS version 22.0 to conduct the tests required for the achievement of the research objectives. The descriptive analysis was used to present the background details of the respondents, the mean and standard deviation analysis. A pilot study was conducted to examine the validity of the questionnaire, to ensure that the questions involved are sufficient to fulfill the objectives of the study, and to add or improve on the content, organization, simplicity, and grammatical mistakes of the questions. The pilot test is a small study done before the real distribution of the questionnaire (Janghorban et al., 2014). In this case, the pilot study was conducted among the research students and lecturers at the university whose focus is related to the topic of the study. In this research, random sampling was utilized. This type of sampling is very good in making sure that a large number of populations are represented. The population of this study is defined as the contractors registered under Grade G7 and the number of registered contractors in Johor Bahru is 220 according to CIDB. Thus, the sample sizes for the population of 220 are 140 respondents (Krejcie & Morgan, 1970).

RESULTS AND DISCUSSION

The pilot study was performed by the researcher for enhancing the structure and consistency of the survey and receive any inquiries. The respondents from the pilot study checked the questionnaire items and gave many suggestions and amendments on the items in terms of language, reliability and validity of the questionnaire item. The results were satisfying which shows that the questions were understandable and relevant, assuring the validity of the scales. The actual data of this study were collected from September 2020 until December 2020. The questionnaires were distributed online and sums of 49 questionnaires

were received. All questionnaires were considered as they show that the respondent answered properly. Thus, the total number of questionnaires that were analysed is 49, which represents a 35% return rate. The data and response rate are summarized in Table 1.

Table 1. Response Rate

Population	Sample Size	Questionnaire Returned	Questionnaire Not Returned	Return Rate
220	140	49	91	35%

Table 2. Summary of Demographics

		Frequency	Percentage
Work Position	Project Manger	10	20.4
	Site Manager	6	12.2
	Engineer	22	44.9
	Others	11	22.4
	Total	**49**	**100%**
Academic Qualification	PhD	5	10.2
	Master's degree	18	36.7
	Bachelor's degree	21	42.9
	Diploma	2	4.1
	Others	3	6.1
	Total	49	**100%**
Years of Experience	0-5 years	18	36.7
	6-10 years	12	24.5
	11-15 years	8	16.3
	16-20 years	8	16.3
	21 years	3	6.1
	Total	**49**	**100%**
Types of Projects are Undertaken by The Firm	Government	12	24.5
	Private	21	42.9
	Both government and Private	16	32.7
	Total	**49**	**100%**
The number of projects completed by the company has using IBS	Less than 3	19	38.8
	3-5	16	32.7
	5-10	10	20.4
	More than 10	4	8.2
	Total	**49**	**100%**

Table 2 shows the number of respondents who work as an engineer is 22 respondents which accounts for 44.9%. The second biggest category was those who selected the position category of "others" (health officer, environmental officer, site safety, safety supervisor, and architect). Their number was 11 respondents, and their percentage was 22.4. This was followed by the respondents who work as project managers with an almost similar number and percentage (10 respondents and 20.4%). The last and the smallest category was those respondents who are working as site managers. Their number was 6 respondents, and their percentage was 12.2. Secondly, the qualifications of the respondents were divided into five categories. Based on the collected data, the majority of the respondents are having Bachelor's degrees. Their number was 21 respondents which accounts for 42.9 of the overall number of the respondents. This was followed by those who have master's degrees as their number amount 18 respondents and account for 36%. The number of respondents who have Ph.D.

degrees was only 5 respondents (10.2%). Diploma holders were the smallest number (2 respondents) which is only 4.1%. In addition, 3 respondents selected the option "Others" whose percentage is only 6.1%. Thirdly, the questionnaire has also asked about the experience of the respondents. Based on the collected data, the majority of the respondents have experience of fewer than five years in the construction industry. Their number is 18 respondents, and their percentage is 36.7%. The second category is those who have experience of 6 to 10 years working in the construction industry. Their number was 12, and their percentage accounts for 24.5%. Interestingly, both categories of respondents who have experience of 11 to 15 years and 16 to 20 years have the same number of respondents (8 respondents) and the same percentage (16.3%). Finally, the number of respondents who have experience of 21 years and above were only 3 respondents and their percentage was 6.1%.

In addition, the respondents were asked about the type of projects conducted by the firm. Based on the collected data, the majority of the respondents are from companies that conduct housing projects in the private construction sector. This was followed by the "both government and private" whose number was 16 (32%). The number of housing projects undertaken in the private sector was 21 housing projects which account for 42% of the total projects. The number of the projects undertaken in the government sector was 12 which is 24.5% of the total number of projects. Last but not least was the number of projects conducted by the firm using IBS. A big number of respondents indicated that the company has conducted less than three housing projects using IBS in Johor. Their number was 19 respondents, and their percentage was 38.8%. The second category is those respondents who are working in companies that have conducted between 3-5 housing projects using IBS. There was a number was 16 (32%). In addition, the number of respondents who are working in companies that have conducted between 5-10 housing projects using IBS was 10 (20%). Finally, the option "more than 10 respondents" was selected by 4 respondents (8.2%).

Impacts of COVID-19 on IBS Usage for Housing Projects

The first objective of this research was to investigate the impacts of IBS implementation in housing construction projects in Johor due to COVID-19. Based on the data presented in Table 3, the first main effect is the new safety regulations on construction workers due to COVID-19. This scores the highest mean value among the others of 4.02. It was ranked as the first, which shows that most of the respondents strongly agree with the statement. The second effect was that IBS implementation Improves the overall supply chain management in IBS implementation due to COVID-19. This statement scored a high mean value of 3.84. This also means that most of the respondents agree with this statement. The third main effect based on the collection is that using IBS due COVID-19 reduces demand on unskilled foreign workers in housing projects in Johor. The third effect of IBS implementation was in the ranking was reducing demand on unskilled foreign workers in housing projects due to COVID-19. This is a positive effect. The fourth effect was the full implementation of IBS in housing projects due to COVID-19Increases cost saving. The mean value of this statement was a high of 3.67.

The other statement scored medium or average mean values which means the respondents whether agree or give neutral stand to the statements. Based on the data, the fifth effect in the ranking was that full implementation of IBS protects construction workers from COVID-19. This statement scored a mean value of 3.63. This was followed by the effect of the new

government policies and regulations on IBS implementation due to COVID-19. This is in fact a negative effect. The statement scored a mean value of 3.61 and was ranked as the sixth effect. The seventh effect was that IBS increases time-saving with a mean value of 3.59. The effect ranked as number eight was the usage of IBS due to COVID-19 increases training requirement for construction workers. This statement scored a mean value of 3.47, increasing the percentage of IBS and improving productivity were the last two impacts that are positive which score mean values of 3.45 and 3.37 respectively.

Table 3. Impacts of COVID-19 on IBS Usage for Housing Projects

No	Item	N	Std. Deviation	Mean	Mean Range	Ranking
1	Increases IBS implementation in housing project due to COVID-19.	49	1.001	3.45	Medium	9
2	New safety regulations on construction workers due to COVID-19.	49	.924	4.02	High	1
3	Protect construction workers from COVID-19 by full implementation of IBS.	49	.906	3.63	Medium	5
4	Improve overall supply chain management in IBS implementation due to COVID-19.	49	.800	3.84	High	2
5	Improve productivity of housing project by using IBS due to COVID-19.	49	1.035	3.37	Medium	10
6	Reduce demand on unskilled foreign workers in a housing project by using IBS due to COVID-19.	49	.895	3.69	Medium	3
7	Increase time-saving by full implementation of IBS in housing project due to COVID-19.	49	.934	3.59	Medium	7
8	Increase cost saving by full implementation of IBS in housing project due to COVID-19.	49	.875	3.67	High	4
9	New government policies and regulations on IBS implementation due to COVID-19.	49	1.057	3.61	Medium	6
10	Increases training requirement for construction workers on IBS usage due to COVID-19.	49	1.120	3.47	Medium	8

The last question in this section on the questionnaire was an open answer question asking respondents to specify other current impacts of IBS implementation on housing construction projects due to COVID-19. Fourteen respondents answer this question and give different answers. The first respondent indicated that using IBS increases time-saving, while the second respondent states that IBS reduces workers' number. The third respondent says that monopoly power plays a role in the market. Another respondent says that using IBS slows the work progress. The fifth respondent states that competitive pricing for the bigger market group is another effect. The sixth person says that COVID-19 in a way is causing a delay in IBS implementation due to cash flow. Reducing unskilled foreign labor is another idea proposed by the seventh and ninth respondents, while the tenth respondent was with the opinion that using IBS delays production and delivery time. Another respondent states, that using IBS means less wet work on-site which could reduce the possibility of injury to the worker (controllable) and minimize, while another wan was with the opinion that using IBS exposes workers to direct sunlight. Finally, the last respondent explained that the IBS construction method should be safer than the conventional method since most of the building components are manufactured in the factory. As long as the correct safe work method statement has been followed during installation, any accidents or near misses can be avoided.

Discussion of Findings

The first main statement that was ranked as (1) is new safety regulations on construction workers due to COVID-19. In addition, protecting construction workers from COVID-19 by full implementation of IBS was ranked as (5). This shows that respondents agree that IBS implementation has been helping in protecting the workers from the COVID-19 infections. In fact, human capital is the blood of the construction industry as is the case in all other industries and sectors. The construction industry is one of the most hazardous sectors in the world (Abdullah & Wern, 2011), and COVID-19 has added to that issue in Malaysia. The safety of the workers is a very fundamental concern since a long time ago. The finding has been supporting the literature review which confirms that IBS improves the safety of the workers as stated by many researchers such as (Abdullah & Wern, 2011) and (Durdyev et al., 2017). Improving overall supply chain management in IBS implementation due to COVID-19 was ranked as (2) which shows that most of the respondents strongly agree with the statement. A study conducted by (Fateh et al., 2017) revealed that lack of machinery and supplier is one of the issues the contractors face in the application of the IBS. COVID-19 has make countries close their boarders and most of the countries are on movement control to prevent the spread of the pandemic. However, the finding of this study interestingly has proven that IBS implementation in housing construction projects has improved the supply chain.

Reducing demand on unskilled foreign workers in a housing project by using IBS due to COVID-19 was ranked (3). Unskilled foreign workers are a fundamental issue that the construction industry in Malaysia is suffering from. So, the respondents have agreed that IBS implementation in housing construction projects will improve this problem. Increasing time-saving by full implementation of IBS in housing projects due to Covid19 is another positive effect that was ranked as (7) by the respondents. This finding confirms the results of Rahim & Qureshi (2018) and Lim (2016) who study the advantages and limitations of IBS implementation in housing construction projects. Increasing cost saving by full implementation of IBS in housing projects due to COVID-19 was ranked as (4) by the respondents which also shows that IBS helps in reducing the cost of the housing projects. This finding is supported by the researches of (Khalil et al., 2016) and (Mohamad Kamar et al., 2009). New government policies and regulations on IBS implementation due to COVID-19was were also among the impacts which were ranked as (6). Since the pandemic has been something new in all the world, and the Malaysian construction industry has no different, many rules and regulations have been imposed by the government. This has been an obstacle in the implementation of the IBS in housing construction projects.

Increasing training requirements for construction workers on IBS usage due to COVID-19 was ranked (8). This also shows that the implementation of IBS in COVID-19 has increased the need for training more workers. According to Jatarona et al. (2016), the apprehension of the public construction industry is not achieved in Malaysia. It has less expediency, and it does not invest enough in training, research, and development. The findings also support the study of Mohd Nawi et al. (2015) and Loh (2019) which shows the importance of training. Among the impacts was that IBS implementation increases training requirement for construction workers on IBS usage due to COVID-19 which was ranked as (8). The apprehension of the public construction industry is not achieved in Malaysia. It has less expediency, and it does not invest enough in training, research, and development (Jatarona et al., 2016). Thus, a need for training rises. Finally, the last two items were stating

that IBS implementation due to COVID-19 has improved the productivity of the housing construction projects as well as increased the implementation of IBS usage in the housing construction projects in Johor which was ranked as (10) and (9) respectively.

New Practice Approaches on IBS Usage in Housing Projects

The second objective of this research was to scrutinize the approaches of IBS usage practices in housing projects during COVID-19 pandemic. Table 4 shows the mean, standard deviation, and ranking values of the statements. According to the statistics, it can be clearly seen that the mean was high and average or medium. From the results of descriptive analysis shown in Table 4, the mean scores for the statements ranged from 3.98 to 3.43. However, the standard deviation measures the dispersion of variables from their mean. In this study, the value of the standard deviation ranged from 0.890 to 1.091. The first main practice approach that got the highest mean value of 3.98 and thus ranked is allocated new incentives from the government on IBS usage due to COVID-19. This was ranked as the first approach as most of the respondents agreed that it is significantly important for the IBS implementation in housing construction projects in Johor due to COVID-19. The second approaches which was ranked as the second one is "to Promote IR 4.0 technology for communication on IBS usage due to COVID-19" and "Provide skillful workers on IBS usage due to COVID-19". Both approaches scored a mean value of 3.92.

Table 4. New Practice Approaches for IBS Implementation

No	Item	N	Std. Deviation	Mean	Mean Range	Ranking
1	Provide competent team on IBS usage in housing project due to COVID-19.	49	.890	3.86	High	4
2	Allocate adequate contingency allowances plan on IBS usage due to COVID-19.	49	1.021	3.43	Medium	9
3	Allocate new incentives from the government on IBS usage due to COVID-19.	49	.946	3.98	High	1
4	Use up-to-date technology utilization on IBS usage due to COVID-19.	49	.971	3.88	High	3
5	Promote IR 4.0 technology for communication on IBS usage due to COVID-19.	49	1.017	3.92	High	2
6	Increase promotion on IBS usage among developers due to COVID-19.	49	.980	3.55	Medium	7
7	Provide additional safety facility on IBS usage due to COVID-19.	49	.969	3.76	High	5
8	Provide skillful workers on IBS usage due to COVID-19.	49	.997	3.92	High	2
9	Educate workers on new safety regulations in IBS usage due to COVID-19.	49	1.091	3.65	Medium	6
10	Develop risk management team to control disasters due to COVID-19 on IBS usage in the housing project.	49	1.042	3.45	Medium	8

The third practice approach in the ranking was to use up-to-date technology utilization on IBS usage due to COVID-19. This statement also scored a high mean value of 3.88. This was followed by the approach of providing a competent team on IBS usage in housing projects due to COVID-19. It was ranked as the fourth important approach because it scored a high mean value of 3.86. The fifth approach that scored a high mean value of 3.76 was "to provide additional safety facility on IBS usage due to COVID-19". Furthermore, the other statements

also were important although they scored a medium mean value which shows that the respondents also agree that they are important. "To educate workers on new safety regulation in IBS usage due to COVID-19" was in the sixth rank with the mean value of 3.65. This mean value shows that most of the respondents agree that this approach is important for the implementation of IBS in housing construction projects due to COVID-19 in Johor. The seventh approach based on the mean value was to increase promotion on IBS usage among developers due to COVID-19. This statement scored a mean value of 3.55. This was followed by developing a risk management team to control disasters due to COVID-19 on IBS usage in the housing project. This approach was ranked as number eight with a mean value of 3.45. The last approach based on the ranking was to allocate adequate contingency allowances plan on IBS usage due to COVID-19. This approach was ranked as number 9, and its mean value was 3.43.

The last item of the section in the questionnaire was asking the respondents to state other practices for the IBS implementation in housing projects due to COVID-19. Only nine respondents give comments on these open questions while the other respondents stated that they have no comments. The first respondent stated that IBS to be interpreted within Architect Consultant and be advised by C&S Consultant then the cost to be evaluated by Quantity Surveyor (QS) to fit the current conventional method. The second respondent indicated that the majority of housing uses IBS, but the price is still expensive. All the big developers have no more honesty all chasing profit. The third respondent expressed that the legal part in construction i.e., construction contract and specification of the project should play the main role in encouraging the user and application of IBS in construction practice. Moreover, in the time of pandemic where limited numbers of construction workers are allowed to be in the construction site. The use of IBS should be promoted by the shareholders to ensure its success in the construction industry. The fourth respondent was of the opinion that lowering down restriction of total manpower on site. The fifth author said the solution is to embrace BIM. The sixth respondent indicated that a study is required in terms of investigation and validation processes among non-Malaysian IBS practitioners to generalize and enhance the applicability and validity of the current approach of an effective integrated team in the Malaysian construction project. The seventh respondent was with the opinion that to introduce proper time management to adhere to MCO by MOH. Another respondent said that IBS instruction to guidelines and improving cost. The last respondent indicates that they should Increase the training labour.

Discussion of Findings

According to the results of this objective, the mean scores for the statement ranged from 3.98 to 3.43. This shows that the respondent agrees on all the proposed practices although the means were not high. Overall, all the respondents have agreed that the government should allocate new incentives for IBS usage due to COVID-19. In turn, the government will be able to increase the usage of the IBS in housing construction projects. Thus, initiatives by the government have been portrayed among the other practices. Besides, promoting IR 4.0 technology for communication on IBS usage due to COVID-19 as well as providing skillful workers was recognized as an essential step to improve the effectiveness of the IBS implementation IBS in the housing construction projects in Johor. The respondents also ranked the use of up-to-date technology utilization on IBS usage due to COVID-19 as the third important practice. This shows that the respondents are aware of the importance of

technology for communication. In addition, the results have shown that there is a need for the competent team of the IBS as well as the need for additional safety facilities. This is supported by Ismail, Abdul Rahim, & Ghazaly (2020), the IBS construction should involve modern, contemporary, and innovative design.

CONCLUSION

In conclusion, there are many impacts of IBS implementation in housing construction projects. Among the impacts are new safety regulations on construction workers, improving overall supply chain management, reducing the demand on unskilled foreign workers in a housing project by using IBS due to COVID-19, increasing cost-saving, and protecting construction workers from COVID-19 by full implementation of IBS. While the same time the new government policies and regulations on IBS implementation due to COVID-19 have been a negative impact. Many new practice approaches were highlighted. However, the most impacts of COVID-19 on IBS usage for housing construction projects were the new safety regulations, improving the supply chain and reducing the unskilled foreign worker, increasing cost saving by full implementation of IBS, and protecting construction workers from COVID-19 disease. All of these were having high mean. While some other statements were having a medium mean including new government policies and regulations, increase time, increases training requirements, increases IBS implementation, and improve productivity. On the other hand, the study has highlighted some practices such as allocating new incentives from the government, promoting IR 4.0 technology for communication on IBS usage, using up-to-date technology utilization on IBS, and providing a competent team on IBS usage in housing projects due to COVID-19. In addition, the finding has illustrated that there is a need for training and development of workers in terms of IBS application. Furthermore, the respondents recommend some new practice approaches for IBS implementation including allocating new incentives, using up-to-date technology, and providing skillful workers, providing a competent team on IBS, and providing additional safety facilities. However, some items were having medium mean including educating workers on new safety regulations, increasing promotion on IBS usage among developers, developing a risk management team to control disaster, and allocating adequate contingency allowances plans. Finally, this study has been effective in highlighting the impacts of COVID-19 in IBS implementation in housing projects and proposed some new practices that can help in the development of the overall implementation of IBS and improvement.

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MUNICIPAL SOLID WASTE DISPOSAL MANAGEMENT: KOTA SAMARAHAN, SARAWAK

Sulzakimin Mohamed[1,2], Mohamed S[3], Seow Ta Wee[1,2], Norliana Sarpin[1,2], Md Asrul Nasid Masrom[1,2], Roshartini Omar[1,2], and Goh Kai Chen[1,2]
[1]Department of Construction Management, Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Malaysia.
[2]Center of Sustainable Infrastructure & Environmental Management (CSIEM), Faculty of Technology Management & Business, Universiti Tun Hussein Onn Malaysia, Parit Raja Malaysia.
[3]Kota Samarahan Municipal Council, Kota Samarahan, Sarawak, Malaysia.

Abstract
Human activities create waste, and the ways that waste is handled, stored, collected, and disposed of can pose risks to the environment and to public health. Solid Waste Management (SWM) includes all activities that seek to minimize health, environmental, and aesthetic impacts of solid waste. In urban areas, especially in the rapidly urbanizing cities of the developing world, problems and issues of Municipal Solid Waste Management (MSWM) are of immediate importance. Hence this study is to examine and ascertain the attitudes and the perceptions of the waste collecting scheduling in Samarahan, Sarawak. This research adheres to by reviewing relevant literature and quantitative method which include distributing the questionnaire to 40 respondents. The results of the research provide quantitative evidence in support of the notion that failure to collect waste according to the schedule appropriate and problem of waste liquid dropping after collection are needed to improve for the solid waste management in Kota Samarahan. Furthermore, this study can encourage key stakeholders in solid waste management to increase their attention on increasing the awareness and helps to the better achievements of future sustainable solid waste disposal management.

Keywords: *Kota Samarahan; municipal waste; waste disposal management.*

INTRODUCTION

Living the notion of sustainable development was first proposed by the Brundtland Commission in 1972. This definition has evolved since the United Nations Earth Summit held by the United Nations Environment Programme (UNEP) in 1992 at Rio de Janeiro. The characterization on the impact of economic, social and environmental development was discussed accordingly and a major concern at local governments globally when dealing with municipal waste. In urban areas, especially in the rapidly urbanizing cities of the developing world, problems and issues of Municipal Solid Waste Management (MSWM) are of immediate importance (Kirama & Mayo, 2016; Schneider, 2017). Most governments have acknowledged the importance of MSWM; however, rapid population growth overwhelms the capacity of most municipal authorities to provide even the most basic services. According to a United Nations Development Programme survey of 151 mayors of cities from around the world, the second most serious problem that city dwellers face (after unemployment) is insufficient solid waste disposal (Paper, 2012; UNDP, 1997).

Typically, one to two thirds of the solid waste that is generated is not collected. The uncollected waste is dumped indiscriminately in the streets and in drains, causing flood, breeding of insect and rodent vectors, and spreading of diseases. Even waste that is collected is often disposed of in uncontrolled dumpsites or burned, polluting water resources and the air. In many cities, Municipal Solid Waste (MSW) contains human and animal excrement as well as hazardous chemical pollutants and sharps. All facilitate disease and injury, especially

among children, rag pickers, and employees in the waste management sector. Major studies have shown that a high percentage of workers who handle refuse and of individuals who live near or on disposal sites are infected with parasites, worms, and related hazardous organisms (Ferrara, 2011; Ramakrishna et al., 2020; Widiyanto et al., 2019; Zero Waste Scotland, 2010). Not only are the quantities of waste increasing commensurate with the growing economy and expanding population, but the composition is also shifting towards plastics and paper packaging, a reflection of improved standard of living.

The implementation of MSWM practices benefits both public health and environmental quality directly and substantially. Waste services are generally the least developed of the environmental services traditionally delivered by local authorities (Herrmann & Bucksch, 2014; Jiang & Liu, 2018; Sekhon & Karthigesu, 2017). With very few exceptions, authorities have not so far developed or applied integrated management techniques or innovative technology solutions. As such, to carry out integrated solid waste management, local governments also need partners. The general community, which is probably the most important stakeholder in waste management activities, must also actively involve or participate in the solutions by modifying their behaviour patterns. At present, public or community perception of local authority performance on waste is poor because of the environmental impact and visibility of waste. Therefore, a systematic way of collecting waste must be an important agenda for any local authority.

LITERATURE REVIEW

Kota Samarahan is still considered in its early stages of development of becoming major city in Sarawak. Therefore, it is crucial to take into account every socioeconomic aspect in all its developmental planning and implementation. One of which is considered pivotal in long-term development plan is waste management. Waste Management should be placed as a priority in order to reduce negative environmental impacts (Ağaçsapan & Çabuk, 2020; Edjabou et al., 2015; Haron et al., 2005). In addition, as Samarahan population grow rapidly due to the migration of people following the rapid development transformation the amount of waste has increases drastically.

Thus, it is questionable whether waste management systems are being implemented effectively when it comes to addressing waste in Samarahan. The author sees it as the problem in the management with regards to waste management. This question has been the subject of extensive research recently (Govender et al., 2011; Herrmann & Bucksch, 2014; Sahar & Ahmad, 2019; Sekhon & Karthigesu, 2017). In general, it is clear that failings exist in terms of improper management such as follows;

- Collection frequency
- Machineries and
- No proper signage regarding waste collection schedule

As with wide areas of this topic, thus practitioners, stakeholders and policy-makers working in the local government are calling not only for a systematic way of waste collection but for a shared framework and classification system, particularly when looking to encourage and implement systematic ways of waste management (Abba et al., 2013; Gumasing & Sasot,

2019; Herrmann & Bucksch, 2014). Hence, the Government must have the effective solid waste management and tactical-level operations to generate interest and awareness.

Past researches find that Malaysian Local Governments face the challenges where they need to tackle municipal solid management (Nor Hafizah et al., 2020; Seow et al., 2017; Mohamed et al., 2018; Introduction Zero Waste Scotland, 2010). Moreover, the demands for better services are on the rise. Hence, Local Government is often viewed as an institution that provides services to its local communities, where the responsibilities in exercising great influence over the social and economic wellbeing of local communities (Gorwood & Gorwood, 2018; Handzic, 2009; Johnson, 2017). This means that it is where a local community is served by a government that is local and near to the community.

Moreover, local government takes responsibility for the environment, social and economic development of that the good governance should have proper top to down approach knowledge transfer practices (Mohamed et al., 2014; Valencia-Vázquez et al., 2014). The local government through the policy, programs, plans, and strategies-oriented people to choose sustainable development and should be shown in the solid waste management. However, solid waste management cannot develop without an appropriate knowledge in governance. Hence, knowledge transfer can be thought of as a cycle where knowledge is communicated around in the organization and to the community via a variety of methods. Moreover, it is crucial working at various levels of management to promote the sustainable development in terms of solid waste management in local government. This study aims to study the perceptions of local community towards local governments of its role in solid waste management.

The local governments' function involves large resources and variety of mechanisms (Gorwood & Gorwood, 2018; Kusakabe, 2013; LASD, 1997). More often than not, implementation and enforcement are not under great obligation to reflect sustainability deliverables especially in dealing with municipal solid waste. Hence, the knowledge of solid waste management should be inculcated as in training and encouragement from management. Therefore, local governments should not perceive solid waste management as a luxury addition to normal practice or a necessity to drive business and development decisions. It should motivate local governments as well as stakeholders to equip its staff member with adequate knowledge of solid waste management.

RESEARCH METHODOLOGY

The research involves three main steps. Step 1 will involve in conducting a literature review and desk research. Information will be gathered from academic's journal, publication, related articles, and documentary and government reports where available. While Step 2, survey method is implemented by means of questionnaire distribution to respondent. Survey data can be collected either through face-to face interview, telephone interview or postal questionnaire. Step 3 involved the use of quantitative method. Edjabou et al. (2015) and Yilmaz (2013) indicate five research styles: experiment, survey, action research, ethnographic research and case study. A detailed literature review, including a Web-based search and a review of academic and industrial literature, was undertaken. There is no definite rule as to which one to select when doing research. It all depends on the nature and scope of the thesis,

the sources of the data, the research questions and hypotheses or proposal, and constraints and scope of the research (Bryman, 2007; Widiyanto et al., 2019; Yin, 2009).

In relation to this, G-Research (2012), Kinemo (2019) and Piaw (2014) highlight that while quantitative research is concerned with issues such as how much, how often and how many, qualitative research on the other hand is concerned with identifying certain phenomena based on an in-depth exhaustive investigations and analysis. Moreover, researchers adopting a qualitative perspective are more concerned to understand individuals' perceptions of the world or the environment around, which they seek understanding rather than statistical analysis.

As for this study, a quantitative method involves mostly with the random survey of the field data. A quantitative method approach such as doing a survey is good for probing the general patterns and common properties as a whole as to study the solid waste management in Kota Samarahan, Sarawak. Therefore, would be effective in generating the explanation behind what, why and how things are done the municipality. Therefore, this research is to provide knowledge on percentages and figures for decision-making and more reportage in nature as in the quantitative method approach.

FINDINGS AND DISCUSSION

The pilot study conducted acknowledged many suggestions in terms of unrelated and disjointed questions, rephrase some questions, shorten the sentences, reduce the questions, and add more questions on the knowledge transfer. The reliability analysis was carried out in order to investigate the internal consistency of the scales used in this study. The results were satisfying, with Cronbach's coefficient alpha value ranging from 0.776 to 0.940.

The results based on the empirical investigations. First, a brief descriptive analysis of the data on the sample of 40 respondents which serve to reflect the characteristic of the population. In this study, the SPSS (Statistical Package for Social Science) is used. The sample is described by giving the basic statistics of the respondents and ventures under study. Second, trying to answer questions pose earlier using simple data tabulation, cross tabulation and chi square test in cross tabulation.

At earlier stage, the uses of descriptive statistics, frequencies and cross tabulation are best and most common solution to detect any abnormalities or mistake during the process of data key in. In addition, the data are organised and information are displayed in a meaningful way.

Table analysis was for the respondent background which includes gender, age, race, education level, marital status, number of family, profession, salary scale and their activities as shown from Table 1 to Table 2. Based on the chart below, majority of respondent are male 55% and female 45% in which most of them are at the age of 41 to 50 years old of cohort. Most probably by that age most of the respondents are already married and either already bought a house or renting it.

Table 1. Details of Respondents

Number	Information	Data
1.	Gender	Man - 55% Woman - 55%
2.	Age of Respondent	41-50 Years - 37.5% 21-30 Years - 25% > 51 Years - 20% 31-40 Years - 17.5%
3.	Race of Respondent	Malay - 72.5% Iban - 17.5% Others - 7.5% Chinese - 2.5%
4.	Level of Education	Secondary School - 50% Bachelor - 20% Primary School - 17% Diploma - 8% Master and Above - 5%
5.	Marital Status	Married - 60% Bachelor - 40%
6.	Number of Family	8-9 - 22.5% 6-7 - 22.5% > 10 - 20% 4-5 - 20% < 3 - 15%
7.	Salary Scale	RM 1001- RM1500 - 47.5% RM 501 - RM 1000 - 17.5% RM 1501 - RM 2000 - 15% <RM 500 - 15% <RM3001 - 5%
8.	Home Cooking (Days)	Everyday - >80% Others - <20%
9.	Quantity of Garbage (Kg)	1-3 Kg - 50% 4-6 Kg - 20% 7-10 Kg - 20 % Others - 10%

Then majority of the respondents are Malay 72%, Iban 17.5% and follow by others. While in term of education basically most of them obtain secondary school education. Additionally due to the fact that most of the respondents are SPM holders, thus it is quite obvious most of them worked as a clerk or general workers with salary range from RM1001 to RM1500. In other side, the data also shows the activities of respondents in term of dinner outing, frequency of home cooking and the average of quantity of garbage that they produce. It can be seen from the data that whether they cook or having inner outside, most of them produce an average of 1-3 kilo of garbage.

Table 2 shows the descriptive statistical analysis by using the SPSS.As such, access to waste collection points varies greatly according to the respondent. The descriptive statistics showed that the overall mean for A to E, H and J is about 2 to 3. It can be deduced that factors from A to E, H and J majority of the respondent disagree with the statement given and thus it reflect that most of them are not satisfied with the frequency of the services given and the contract are not based on schedule. These problems have been discussed and need further improvement in order to have a healthier lifestyle (Firuza & Khan, 2011; Ramdhani et al. 2018; Rushton, 2003; Sekhon & Karthigesu, 2017).

Table 2. Conclusion from Respondent

ITEM		N	Min	Max	Mean	Std. Deviation
A	Frequency of service is satisfactory	40	1	4	2.13	.966
B	Contract of service is according to schedule	40	1	4	2.25	.870
C	No remaining waste after collection	40	1	4	2.18	.844
D	Garbage bin is at it original position after collection	40	1	5	2.55	1.037
E	Garbage bin is in a good condition after collection	40	1	4	2.85	.949
F	Rubbish/waste is scattered around after collection	40	1	5	3.33	1.228
G	Problem of waste liquid dropping after collection	40	1	5	3.53	1.664
H	Waste/rubbish is crammed in front of our house or business premises	40	1	5	2.75	1.149
I	Frequency of service is satisfactory	40	1	4	2.13	.966
J	Illegal dumping	40	1	4	2.98	1.250
K	Blocked drain	40	1	4	3.40	1.008
L	Problem of smell/stinking	40	1	4	3.73	1.377
M	Problem with rodent and wild animals	40	1	4	3.55	1.176
N	Sour eye view/aesthetic value problem	40	1	4	3.70	1.244
O	Facilities being vandalised	40	1	4	2.93	.971
P	Incurred high management cost	40	2	5	3.58	.747
Q	Location of the container is not suitable	40	1	5	3.20	.823
R	Failure to collect waste according to the schedule	40	2	5	4.30	.883

In addition, remaining waste is still a problem after collection. In addition, when the activities are not properly managed by the local governments, the negatives impact as flooding are imminent and it will cause hazards to society, economy and environment as shown in problem of foul smell/stinking (L), problems with rodent and wild animals (M) and problem of waste liquid dropping after collection (G) as shown with mean value of 3.73, 3.55 and 3.53 respectively. In response to other studies which highlight that without proper knowledge and management, the problems of rodents and waste leakage could become a potential pollution contributor (Candeias & Morhard, 2018; Mohamed et al. 2015; Sahar & Ahmad, 2019).

Respondents responded that there is no major issue on crammed rubbish or illegal dumping within the vicinity. On the other hand, for factors F to G, I and K to R showed that the overall mean is about 3 above to 4 plus. Thus, majority of the respondent agree that there is a lot of problem associated with waste management issues such as waste residue, foul smell, rodent and wild animals, and it is stated in past studies (Moh & Abd Manaf, 2014; Rushton, 2003; Yu & Solvang, 2016). It is an indication that the municipal has to improve on their waste management especially in term of service frequency and adhering to the schedule.

Daily collection of waste not only requires a larger work force with a weekly collection system, but also has a significant impact on equipment and its maintenance. The activities involve in waste handling and separation is linked to the management of waste before they deposited in storage container for collection later. Management is comprising of the progress of loading containers to the point of collection (Jiang & Liu, 2018; Kirama & Mayo, 2016). Processing begins with the recovery (separation) from the resources and ready to be treating or ends at their destined users. Moreover, it is quite clear from the survey result that frequency of collection of waste also an important issue, especially those in further up the town of Samarahan whereby collection is not based on schedule and most of the times respondent are not happy with their services.

All respondent view that Local Governments have played some role in imparting awareness in sustainable development to the public. Since sustainable development issues have been around for more than 10 years now and Local Governments should already impart awareness with sustainable development principles (Gorwood & Gorwood, 2018; Johnson, 2017; Singaravelloo, 2010). Moreover, collection of waste from sites or premises located in inaccessible streets and alleys is problematic, and this is accentuated in localities like villages and squatter settlements with narrow or unformed roads and poorly developed collection systems or even for those places which are not favourable to the services providers.

CONCLUSION

Living Generally, the conditions of waste disposal in Kota Samarahan, Sarawak, Malaysia can be considered similar to those in many developing countries within the tropical climates. However, the problems associated with open dumping of waste are still at large. As such, open refuse dumps are most commonly located at the perimeter of major hosing areas in Kota Samarahan. Open dumps are generally sited based on considerations of access to collection vehicles rather than hydrological or public health considerations. In rural areas of Kota Samarahan, there are basically limited vehicles for collection hence uncontrolled dumping occurs within the built-up areas - with all its attendant health hazards and negative environmental impact. These conditions can be clearly seen especially in some parts of Asajaya. There are a number of relevant waste management principles that contribute to reduce waste volumes; however, it is questionable whether their values have been realized. The analysis of the current situation reveals key knowledge deficit areas including the following:

- Experiences with resource mobilization for solid waste management in Samarahan are still lacking due to the facts that most respondent are not satisfied with their services from all perspectives.

- For as long as people have been living in settled communities, the accumulation and dumping of rubbish, or garbage, has been a significant issue especially in Kota Samarahan now with rapid development and are going for an education hub. The disposal of items that are spoilt, degraded, expended or simply no longer of use to the owner has become an increasingly important issue. If solid wastes are not managed properly, many risks and hazards for human welfare can result, although the relative importance of each depends on local conditions.

In addition, based on the respond by the respondent it can be deduce that:

- Uncollected wastes block drains can cause flash floods, generate insanitary conditions, and are a visual annoyance;
- Unwanted cans and tyres encourage the breeding of flies, mosquitoes and other vectors that spread disease;
- Uncollected or inappropriately dumped or decomposing waste attracts rodents that cause damage and spread disease, and aerosols and dust spread fungi and pathogens;
- Polluted water (leachate) flowing from waste dumps and disposal sites can cause serious pollution of groundwater and waterways;

- Waste inefficiently disposed of is an aesthetic nuisance because of its unsightliness and unpleasant aroma;
- Liquids and smokes escaping from chemical wastes or as reactions from mixing different types of waste can be hazardous;

Therefore, new landfill site is urgently needed with proper selection of the environmental impact assessment and construction. Thus, if it all possible, a proper waste management system could be implemented. Hence, Kota Samarahan can only be a better place to live in provided that sound waste management is evidenced.

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ADVANCING THE NOTION OF MASLOW HIERACHICAL NEEDS THEORY INTO RETIREMENT VILLAGE SUSTAINABILITY NEEDS

Sharifah Rahama Amirul[1], Asmah Alia Mohamad Bohari[2], Farah Ajlaa Julaihi[2], Mohd Azrai Azman[2] and Kuryati Kipli[3]

[1]Faculty of Business, Economics & Accountancy, Universiti Malaysia Sabah, Kota Kinabalu, Sabah Malaysia.

[2]Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, Cawangan Sarawak, Kota Samarahan, Sarawak, Malaysia.

[3]Department of Electrical and Electronic Engineering, Faculty of Engineering, Universiti Malaysia Sarawak, Kota Samarahan, Sarawak, Malaysia.

Abstract

The retirement village (RV) sector is booming and expanding its market as the world's ageing population has grown in recent years, notably in industrialised and developing countries. RV refers to a high-quality housing facility for retirees wanting to continue living independently in a safe and comfortable environment during post-retirement. In response to the demands of a sustainable development, sustainability of RV has been one of the critical focuses in existing literatures. Thus, this paper aims to advance the notion of Maslow hierarchical needs theory into the setting of retirement villages. The proposed framework of this paper offers a structured and thorough understanding of aged elderly requirements and aspirations; starting with the most fundamental of aged requirements and progressing to the highest desire of having a high quality of life during their golden years, which presents unique prospects for making a theoretical contribution to the requirements of the ageing population and improving RV sustainability.

Keywords: *Maslow hierarchical needs theory; retirement village.*

INTRODUCTION

Ageing population has been a pressing concern in high income or industrialised countries, for instance Japan, in which more than a quarter of Japanese were 65 years and older in 2020. Japanese population rate has stalled and begun to decline (O'Neill, 2022). The World Health Organisation (WHO) in its recent report indicated that by 2030, one out of every six persons on earth fell into this age group, and from this point, the population aged 60 and above is anticipated to surge from 1 billion in 2020 to 1.4 billion in 2050. It is projected that by the year 2050, the world's population of people aged 60 and above will be more than doubled from its current population (2.1 billion). Approximately 426 million people will be 80 years or older by 2050, a threefold increase from the current population (WHO, 2021). The ageing population in the emerging countries or middle income as well as low-income countries will also see their ageing population start to climb up. By 2050, two-thirds of the world's population over 60 years will be residing in low- and middle-income countries as well (WHO, 2021).

The growing number of ageing populations has drawn an attention to the retirement village business, which is striving to meet the demands or quality of life for the elderly (Lim et al., 2020; Ruth et al., 2021; Tan et al., 2021). A conducive retirement village strives to provide an excellent living environment for residents by addressing their basic needs first and foremost, then subsequently their sustainable needs, which are long-term expectations. To attract older individuals to move into a retirement village, it is imperative to provide their

basic needs encompassing the design of the entire village's physical environment, which includes the village's location, available facilities and accessibility, as well as the design of outdoor and indoor spaces (Ruth et al., 2020). To gain a better understanding on the needs of elderly individuals in establishing sustainable retirement village, this paper aims to advance the notion of Maslow's hierarchy of needs theory. Maslow identified five tiers of needs, arranged from lowest to highest needs: physiological needs, safety and security needs, belonging and love needs, esteem needs, and self-actualisation needs (see Figure 1). Specific requirements for a sustainable RV framework will be addressed in this paper in accordance with the application of the Maslow theory (see Figure 2).

Retirement Village, the New Living Style for Elderly

Studies show that most expenses increment of the elderly are due to disabilities and poor health condition (Lee & Mason, 2017; NIA, NIH & WHO, 2011). Hence, a healthy ageing lifestyle is important to curb the increase in medical expenses as well as reduce the potential of having to work in old age. In order to ensure aged population can live in a healthy, active and conducive lifestyle, empowerment of knowledge, skills and appropriate environment as well optimum health facilities and services are required. The concern has been underlined in the National Health Policy for Older Persons 2008 (Ministry of Health, 2018).

According to Xin et al. (2019), the ageing population has become a global phenomenon and the concept of retirement village has merged to suit the retirement lifestyle of the elderlies. Retirement village is defined as the ways in which retirement villages are configured whether it only provides accommodations similar to other types of housing or also providing services and supports for their residents (Xia et al., 2015). Retirement villages are communities developed specifically for the elderly. A retirement village is distinguished by its emphasis on independent living, institutionalisation, and an age-friendly environment (Hu et al., 2017).

Xia et al. (2015) suggested the retirement village must also be designed in such ways that support sustainability. The components of environmental sustainability consist of well-known related issues to resource efficiency, a reduced effect on climate change and the ecological system. Savings on construction cost, operating cost, living cost, cost of future modifications and long-term maintenance, as well as having a good resale value and being cost efficient for the community are all components of economic sustainability. Social sustainability includes design for flexibility, comfort, safety, security, belongingness and social engagement (Xia et al., 2014).

Maslow Hierarchical Needs Theory

A very well-known psychologist, Abraham Maslow has made a significant to the growth and development of human psychology, who is widely acknowledged as one of the pioneers of human psychology and motivation in the context of the human environment in contemporary society (Aruma & Hanachor, 2015). In the preface to motivation theory, Maslow (1943a) has initiated a hierarchy of goals, purposes, or needs arranged from the most fundamental to the highest needs. His (Maslow, 1943b) later work formulated a positive theory of motivation and summarised that there are at least five sets of objectives, which referred to as basic needs. These are, in brief, physiological, safety, love, esteem, and self-actualisation needs. Maslow (1943b) is commonly depicted in pyramid shape as shown in Figure 1.

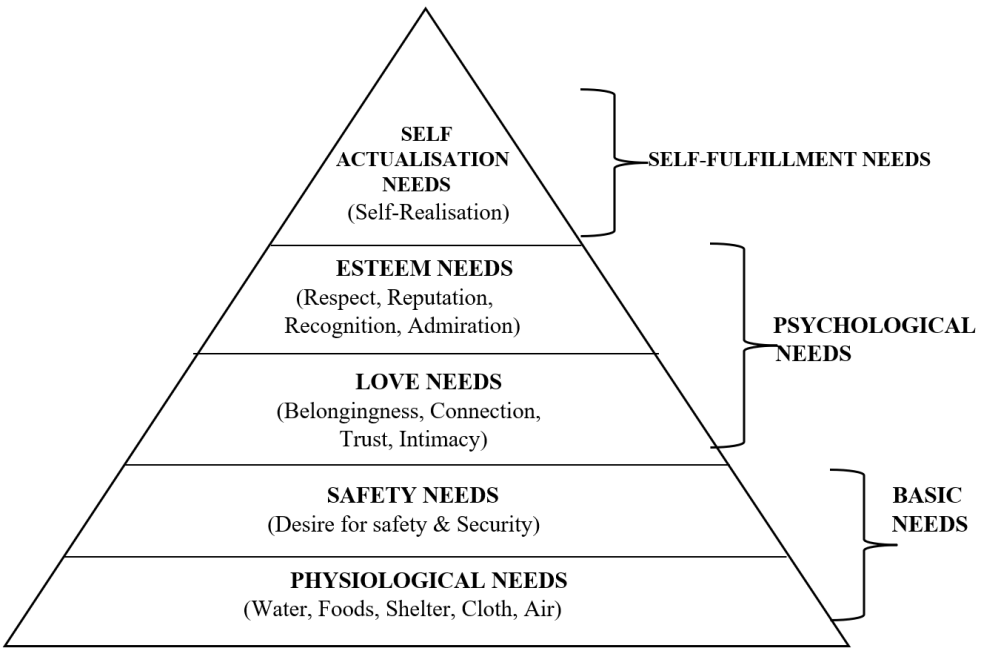

Figure 1. Maslow's Hierarchy of Needs

Basic Needs (Physiological and Safety Needs)

Maslow (1943b) indicates that physiological needs are the most pre-potent of all needs. If physiological needs are unfulfilled, all other needs may simply become non-existent or can be pushed behind. 'Physiological' needs are typically taken as the initial point of human needs and are referred to as physiological drives because they are associated with the preservation of the human body, thus are necessary for survival. Physiological requirements encompass the most fundamental of human requirements, such as food, air, clothing, water, and shelter, among others. If the physiological requirements of the human body are not fulfilled, the body will find it difficult to carry out the activities related to everyday living. In fact, if the human body's physiological requirements are not served, it will struggle for survival. Therefore, these biological needs are important to keep human life from being extinct.

Psychological Needs (Love/Social Needs and Esteem Needs)

In its most basic definition, psychology studies human behaviour and mental experiences. In accordance with Maslow's hierarchy of needs theory, affection and acceptance, as well as a sense of adequacy and self-esteem, are all considered as psychological needs. Once individuals have met their basic needs, they will begin to worry about their belonging to a social group in which they can love and be loved by others in the society (Maslow, 1970; Mulwa, 2008). Among other things, it appears that there is a strong social desire to be identified with and belong to societal organisations such as families, communities, and organisations. Bruggencate et al. (2018) added that humans require social interaction as part of their fundamental needs. Unfulfilled social needs can result in both mental and physical health problems.

Self-Actualisation Needs

Based on the work of Maslow (1962), self-actualisation can be defined as self-realisation or self-cultivation, which defined as the entire realisation of one's potential as manifested in peak experiences that include the full development of one's abilities and enjoyment for life. Carl Rogers (1902-1987) was a humanistic psychologist who concurred with Abraham Maslow's fundamental principles. According to Rogers (1951), "the organism has one basic tendency and striving - to actualise, maintain, and enhance the experiencing organism" (Rogers, 1951, p. 487). From the perspective of Rogers (1951), self-actualization can be further defined as an ongoing, lifelong process in which an individual's self-concept is maintained and further strengthened by reflection and reinterpretation of a variety of experiences that permit the individual to recover, adapt, and develop over the course of their lifetime. Onah (2015) added that the demand for self-actualization or self-realization is necessary for the development of human potential in order to raise the standard of life of people hailing from a variety of groups within the context of the modern global environment.

Advancing Maslow Needs Theory for Sustainable Retirement Village Concept

A sustainable retirement village is a specific or uniquely built, high quality accommodation for people wanting to continue living independently in a safe and enjoyable setting after retirement. According to Ruth et al. (2020), a sustainable retirement village is designed for senior citizens who need to enhance the quality of living environment by providing proper accommodation, services, and facilities which meet residents' social, economic, and environmental needs. The Maslow needs theory will provide a solid foundation in thoroughly understanding the needs of retired individuals, hence will facilitate the development of a sustainable retirement village. This paper extends the concept of Maslow's hierarchy of needs towards delivering more specific requirements in developing a sustainable retirement village. Adaptation of Maslow theory elaborated in this research, advancing into the notion of sustainable retirement village needs perspective, is depicted in Figure 2.

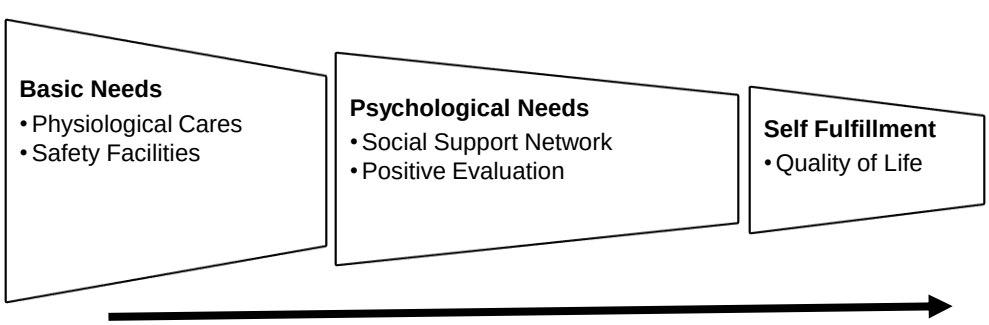

Figure 2. Retirement Village Sustainable Needs

Basic Needs: Physiological Care and Safety Facilities

From the context of a retirement village (RV) that focuses on the needs of elderlies or retirees, the most basic needs are physiological needs. However, there is an important concern to be taken into account in fulfilling the elderly's physiological needs. For instance, an elderly person requires sufficient nourishment in order to be healthy and live comfortably. It will be an added value for sustainable RV to have nutritionists on hand for residents to support them

in maintaining active lifestyles by prescribing good nutrition. When it comes to physiological needs, Maslow (1943b) emphasised two important notions that are necessary to be understood: first, the concept of homeostasis, and second, the revelation that appetites (preferential choice of foods). Those are fairly efficient indicators of actual needs or lacks in the body. The concept of homeostasis was first coined by Walter Cannon (1926), a physiologist, explaining the body's need to reach and maintain a certain state of equilibrium to keep internal states steady and balanced (Kendra, 2021). Similarly, based on the physiological needs in Maslow's hierarchy, RV should consider safety as a part of basic needs. Maslow (1943b) indicated that safety needs came second after physiological needs, and this has been widely acknowledged in existing literatures.

Zheng et al. (2016), on the other hand, argue that the demand for safety arose before the need for physiological needs. In a further explanation of this concept, Zheng et al. (2016) provided an illustration by stating that "the deer cannot eat (physiological needs) on the untamed prairie when the wolves chase them (safety)." The needs for safety that humans have are more fundamental than physiological needs, these needs include personal security, financial stability, health, and overall well-being. A heightened sense of safety is one of the root causes of a variety of mental health issues, including but not limited to anxiety, phobias, depression, and hopelessness (Zheng et al., 2016).

It is undeniable that safety takes precedence over-eating during anxious or emergency moments. However, the given deer example does not reflect the real continuous needs of human. Physiological needs are on a continuous basis for human survival and lacking it will threaten human existence. Therefore, skipping one's meal because of safety reason is not an implicative of physiological needs to be less important than safety needs. Running away from wolves may be impossible for a deer that lack constant supply of physiological needs. Circling back to the concept of homeostasis, physiological demands are critical for maintaining stable, balanced, and optimum internal states in organisms (Deckers, 2018; Kendra, 2021). Hence, this paper sticks to the Maslow (1943b) hierarchy, which prioritises physiological needs first and followed by safety concerns.

The basic needs have been specifically identified as physiological care and safety facilities in the framework proposed in this study. Physiological care is more specific to elderly needs, for example, it is important to provide RV residents with nutritious foods as well as encouraging the residents to have a healthy dietary pattern. A sustainable RV are inextricably linked to the needs of its residents' health care because as people age, their health may deteriorate as well (WHO, 2021). Kourkouta et al. (2016) posit that physical and psychological changes resulted from growing older may have an adverse effect on nutritional status. However, a healthy diet can give a positive effect on the health and mental well-being of elderly individuals. Diet and overall nutrition habits of the elderlies are crucial in maintaining their health (Kourkouta et al., 2016). Hence, RV can also assist its residents in maintaining a healthy diet by giving them access to a nutritionist's advice. In addition, access to general medical assistant will be much favourable at RV. Aside from that, RV residents require a clean shelter equipped with ample ventilation, which helps them in sleeping better whilst simultaneously enhance their general health.

Safety facilities is another need required at the RV. Williams (2019) asserted that when dealing with older individuals, one of the most important considerations is their safety as they are prone to accidents and injuries from internal and external factors. Internal causes include normal ageing physiologic changes, chronic disease, pharmaceutical use, and cognitive or emotional changes. External variables encompass a wide range of potential environmental dangers for older persons. Despite the fact that older person accounts for only around 11% of the population, they account for approximately 23% of total unintentional deaths each year (Williams, 2019). According to National Safety Council research, around 24,000 persons over the age of 65 died each year as a result of accidental incidents (Williams, 2019). In 2016, the Centres for Disease Control and Prevention (CDC), reported over 25% of senior Americans (aged 65 and older) fall, making it the top cause of senior injury and death. CDC (2016) added that approximately one in every three seniors either hurts or dies as a result of a fall every year; every 11 seconds, an older adult is treated in an emergency room for falling; and every 19 minutes, an older adult is killed as a result of fall. Therefore, RV should provide a safer and more secure environment for its residents. Safety facilities for the elderlies must be specifically designed according to their needs. Lim et al. (2020) posits that RV is a novel living option where spaces, services, activities and facilities are tailored to meet the ergonomic needs of the elderly. Thus, amenities and services in the RV shall be based on elderlies' unique requirement (Hu et al., 2019; Lim et al., 2020).

Psychological Needs (Social Support Network Needs and Positive Evaluation)

It is becoming increasingly important to address the social requirements of older people as a result of the expanding population of older people and the requirement that they continue to have healthy and active lives within their communities. Bruggencate et al. (2018) emphasized how crucial it is to address the social requirements of elderly people in order for them to maintain their health. In their examination of the social requirements of adults over the age of 65, Bruggencate et al. (2018) conducted systematic reviews of 14 studies. From these analyses, they derived four major themes, which were generated as follows:

The need for proximity: As an individual gets older, their social network will shrink and tend to spend less time with family and friends. Having a close-by support network will help elderly people feel safer, more comfortable, and more connected to their communities. Relationships with one's neighbours and other members of one's community, who all contribute in meaningful ways to one's overall health and happiness, are just as important as those with one's closest friends or members of one's own family (Bruggencate et al., 2018).

The need for meaningful relationships: Meaningful social interactions bring affection, purpose, and respect. A strong social network can help elderly persons stay healthy and independent. However, elderly fears, for example, in term of financial and time commitment, will burdening their family and friends and family.

The need for reciprocity: The concept of reciprocity has been linked to both geographical closeness and the development of meaningful relationships. Reciprocity helps to fortify ties. The concept of reciprocity encompasses both giving and receiving (whether by volunteering or helping neighbours). Having a sense that one is contributing to the greater good helps older people maintain their sense of purpose and independence.

A diversity of needs: the systematic reviews revealed that not all elderlies have the same social demands; there are disparities according to both individual and cultural factors. Some cultures may be more supportive of (and actively engage with) their elderlies than others, and this may be due to a variety of factors. In addition, not everyone believes that in order to be happy, one must have a large social network of friends and acquaintances. It is important to recognise that older persons' social requirements depend on their personalities, desires, expectations, and cultural backgrounds.

As shown in Figure 2, the next aspect of psychological needs under this paper's proposed framework is positive evaluation, where the foundation of this aspect is self-esteem as indicated in the Maslow hierarchical needs. Self-esteem is a subjective evaluation or judgement of one's own value held by an individual. Typically, when elderlies are relocated to an old folk's home, it is a sad event since it is typically regarded as a situation in which that older individual has been neglected or is unable to be cared for by his or her own family. However, the situation is different in a retirement village since some elder individuals sent to a retirement village are regarded fortunate because they are believed to be enjoying their golden years in a high-quality environment with a modern lifestyle that suits the needs required by the elderly. Because of this positive evaluation, older individuals who are separated from their families feel less depressed than those placed to conventional old folk's home.

Self-Fulfilment: Quality of Life

Ageing population is in tandem with socioeconomic development, including educational expansion (Kye et al., 2014). Global education levels are increasing year after year as the world population became more educated. Pew Research Centre's tabulation in the 2017's Current Population Survey Annual Social and Economic Supplement (ASEC) from the Integrated Public Use Microdata Series (IPUMS) revealed that education levels among the baby boomer generation (born 1946-1964) have begun to rise in comparison to the silent generation (born before 1946). Gen Xers (born 1965-1980) attainment is even higher than baby boomers', and millennial generation (born 1981-1996) educational level is the highest compared to its predecessors. Education attainments are associated with a desire for a higher level of living quality. According to these educational attainment statistics, it is apparent that the demand for quality of life among retirees will increase, thus predicts that the demand for retirement villages is increasing and continues to grow in the future. Another feature associated with the attainment of education level is income level. Edgerton et al. (2012) posit that the attainment of educationally contingent credentials is associated with changes in occupational trajectory, income, and attendant life chances.

Aside from the socioeconomic changes that have led in the desire for better quality of life (QoL) during the golden age, there are a slew of other aspects that are critical for sustainable RV. For instance, Farzianpour et al. (2012) alleged that elderlies have higher probability of diminished physical and mental abilities. Loneliness, impaired sexual activity and chronic metabolic condition are factors that might emotionally disturb an elderly, which can lower their overall quality of life. Additionally, baby boomers and the next generations (X-Gen, Millennial and future generations) are looking forward to leading an active lifestyle and pursuing their interests during their golden years (Hu, Xia, Buys, Skitmore, Kennedy & Drogemuller, 2015).

Therefore, the highest achievement of this paper's proposed model is the self-fulfilment of the resident's quality of life, which is the ultimate goal of sustainable RV. Residents who have fulfilled all their physiological and psychological needs are well on their way to achieve a high quality of life level during their golden years. Moreover, van Leeuwen et al. (2019) in their recent study found that the QoL perspectives from the elderlies can be defined based on nine main domains as follows:

1. Health perception (feeling healthy without physical condition limitation)
2. Autonomy (ability to self-manage, retaining dignity and not feeling like a burden)
3. Role and activity (spending time in activities that bring sense of value, joy and involvement)
4. Relationship (feel supported and means something for others)
5. Emotional comfort (peaceful feeling)
6. Home and neighbourhood (secured home and living in a pleasant and accessible neighbourhood)
7. Attitude and adaptation (looking at the bright side of life)
8. Financial security (not restricted to financial situation)
9. Spirituality (feeling attached to faith, self-development, and inner reflection)

Another study conducted by Xavier et al. (2003) concluded that for elderlies, a negative quality of life is equivalent to loss of health, while a positive quality of life is equivalent to a wider range of categories such as activity, income, social life, and family relationships; all of which differ from subject to subject. In accordance with the proposed framework of this study, both definitions of quality of life provided by van Leeuwen et al. (2019) and Xavier et al. (2003) are three tiers mix of ageing needs as discussed in the proposed framework of this study. To be more specific, based on these combined definitions, this paper would refine the definition for the highest level of RV sustainable needs that is quality of life as the achievement of residents' well-being, peace of mind, spiritual enhancement, financial security and self-development in adapting to their golden years.

DISCUSSION AND CONCLUSION

While the retirement industry is growing at a rapid pace around the world and RV is a feasible modern option for many retirees, more studies and guidance are needed (Zuo et al., 2014). Many retirement village developers strive to provide a sustainable living environment for its residents in response to the demands of the sustainable development movement. This will not be feasible until a thorough understanding of the preferences of retirement village residents for many facets of sustainable living environment is acquired (Bo Xia et al., 2021). This paper presents information from the very basic elderly needs to the highest desire of having quality of life during their golden age by advancing the notion of the Maslow hierarchical needs theory. Based on the development of the framework suggested in this paper, a structured and comprehensive understanding of ageing needs and desires can be addressed for sustainable retirement village.

Recent seminal work done by Bo Xia et al. (2021) demonstrated that the most preferred features of sustainability are independent and convenient living, just and fairness, being respected and valued, and privacy protection. All of these features fell under the triple bottom line dimension of social sustainability.

This paper extends the findings of Bo Xia et al. (2021) by introducing the advanced concept of Maslow's hierarchical needs theory into the sustainable retirement village setting. Following the recommendations in this study, it is proposed that basic needs (physiological care and safety facilities) are the most important fundamental features that must be met in any sustainable RV. For example, Maslow (1943b) emphasised the essentiality of homoeostasis concept in comprehending physiological needs, that is the ability of the body to maintain a stable and balanced state of internal states (Kendra, 2021).

Hence, it is vital for RV to provide its residents with healthy diet or access to nutritionist guidance as it is important for sustaining their overall health (Kourkouta et al., 2016; WHO 2021) such as their physical and emotional well-being (Kourkouta et al., 2016). Safety facilities is another basic need required for sustainable RV because elderly is prone to accidents and injury (Williams, 2019). Therefore, when designing a sustainable RV, it is important to consider the physical environment of the village, which should adhere to the code of design for the elderly and ergonomics facilities, such as the existence of well-ventilated air, slip-resistant flooring, handrails or grab bars to assist elderly's movement, among other things. Thus, amenities and services in the RV shall be based on elderly unique requirement (Hu et al., 2019; Lim et al., 2020).

The second stage in fulfilling a requirement for sustainable RV is the psychological needs of the elderly (social support network needs and positive evaluation). Despite the fact that the retirement village is supposed to provide a comfortable home for the elderly, social support network such as from family and friends is equally important to ensure the RV's residents remain active and preserve their well-being (Bruggencate et al., 2018). There are four essential social needs characteristics of sustainable RV residents that should be considered such as the needs for proximity, meaningful relationship, reciprocity (giving and receiving in relationship) and diversity need (Bruggencate et al., 2018) which can strengthen the social support network in sustainable RV. Bohle et al. (2014) highlighted that RV should not be viewed as the primary factor in the separation and isolation of elderly people from society. Therefore, it is advisable that the retirement village be located within a reasonable commuting distance and not too remote.

The ultimate goal in a sustainable RV is the quality of life of its residents. Residents who have fulfilled their physiological and psychological needs are moving forward to obtaining a high degree in quality of life during their golden years. This paper has combined and refined the definitions from van Leeuwen et al. (2019) and Xavier et al. (2003), which state that the highest level of RV sustainable need is quality of life of the RV residents who enjoyed well-being and healthy life, having peace of mind, spiritual enhancement, financial security, and self-development while adapting to their golden years.

To conclude, the proposed framework of this paper offers a structured and thorough understanding of ageing's requirements and aspirations, starting with the most fundamental of aged requirements and progressing to the highest desire of having a high quality of life during their golden years. This presents unique prospects in making a theoretical contribution to the requirements of the ageing population and improving RV sustainability.

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COLLABORATIVE DESIGN PROCESS WITHIN BUILDING INFORMATION MODELLING (BIM) PROJECTS: BARRIERS AND POTENTIALS

Mohd Yamani Yahya[1], Chang Tung Sheng[2], Azlina Md Yassin[3], Rolyselra Orbintang Robin[1], Roshartini Omar[1] and Norliana Sarpin[1]
[1]Department of Construction Management, Faculty of Technology Management & Business, Universiti Tun Hussein Onn Malaysia, Johor, Malaysia.
[2]Tialoc Malaysia Sdn. Bhd. Suite 2.09, Business Centre, Kulim Hi-Tech Park, Kulim, Kedah, Malaysia.
[3]Department of Real Estate Management, Faculty of Technology Management & Business, Universiti Tun Hussein Onn Malaysia, Johor, Malaysia.

Abstract
Building Information Modelling (BIM) is the most current breakthrough in the construction industry aimed at attaining sustainable construction. It has been adopted in the Malaysian building industry since 2007. There have been several reasons affecting BIM adoption, one of the main challenges is the collaboration of design process within the company. However, Malaysian contractors are currently missing experiences in BIM collaborative design. Therefore, the aims of this study were to identify the hurdles to effective collaborative design utilising BIM technology, and to identify potential improvements on collaborative design. The data was gathered through face-to-face semi-structured interview sessions with the 5 respondents and evaluated using content analysis approach. The results of this study suggested that the main barrier to BIM collaborative design was a lack of coordination among construction stakeholders, which resulted in additional impediments during the design stage. As a result, it is advised that more training be offered to construction actors to enhance awareness of the benefits of adopting BIM in construction projects. However, the respondents stated that with the involvement of government regulation, the use of BIM in the Malaysian construction industry would expand, which would help the construction firm in terms of enhancing collaboration and communication between the construction participants.

Keywords: *Building Information Modelling; collaborative; workflow; barriers; potentials*.

INTRODUCTION

Malaysia's construction industry is still in its early stages of growth, but it is rapidly modernising. Malaysia is working hard to become a high-income country by 2020. This necessitates a significant transformation of the economic system (Olanrewaju and Abdul-Aziz, 2015). The government announced on September 10, 2015, that the Construction Industry Transformation Program (CITP) will consist of 18 initiatives spread across four major areas. These will help to improve the reputation of the construction industry both locally and internationally. One of the Construction Industry Development Board's (CIDB) goals is to prepare and mandate the use of three-dimensional (3D) building plans by 2019 with the introduction of Building Information Modelling, in order to advance the level of automation and use of high technology in the construction industry (BIM). BIM adoption in Malaysia is progressing at a moderate pace, driven mainly by the private sector, which has recognised the significant benefits that can be gained from intelligent BIM adoption. BIM adoption and deployment are no longer the most important problems facing most companies. The design workflow had shifted from conventional to BIM because of BIM implementation (Deutsch, 2011). As a result, teamwork training is expected before the new workflow and design process can be implemented. Professionals and design firms will benefit from collaborative work, whether the collaboration is internal or external (Akintoye, Black, and Fitzgerald, 2000). Firms want to know how to improve the efficiency of their work processes

so that they can focus on what they do best. However, achieving good teamwork remains a major challenge for everyone. As a result, the objectives of this study are to identify barriers to successful collaborative design using BIM technology in construction projects, as well as possible improvements.

LITERATURE REVIEW

Building Information Modelling

Building Information Modelling (BIM) is a process of generating and managing building data during its life cycle. BIM (Housing Information Modelling) is a method of producing and handling data about a building during its life cycle. Building Information Model is created as a result of the process, which includes building geometry, spatial relationships, geographic information, as well as quantities and properties of building components (Lee, Sacks, and Eastman, 2006). Succar (2009) defines BIM as a Computer Aided Design (CAD) paradigm that generates a methodology for managing critical building design and project data in digital format throughout the life-cycle of the building. BIM is a new emerging technology that entails creating a digital image of a building in order to facilitate digital knowledge sharing and interoperability (CREAM, 2014). BIM enables a modern way of working by allowing designers to create projects using intelligent objects. One of the key BIM Software Providers stresses that the data stays reliable, organised, and more precise for all stakeholders no matter how many times the template changes or who changes it (Autodesk, 2008). The accuracy of the data here refers to the ability to operate on a single platform with the most recent changes. It is vital that market participants comprehend and use BIM in their projects. For this reason, The National Institute of Standards and Technology in the United States discovered that consumers pay nearly $16 billion in direct costs per year due to time lost due to insufficient AEC software capability; a fact that immediately confirms the lack of interoperability between today's software programmes (Gallaher, O'Connor, John, Dettbarn and Gilday, 2004).

BIM Collaborative Design

Improving the collaborative design process is one of the most common BIM applications in the construction industry. The BIM principle communication aims to present facility knowledge in a way that can be shared or exchanged (Kreider and Messner, 2013). A high level of collaboration among the design team will result in a more successful project. Many team members working together to efficiently use the 3D model during the project delivery process, as encouraged by BIM, is referred to as collaboration. In the building industry, project teams must use virtual modelling techniques. A virtual model is one tool for ensuring early project coordination. The BIM method is a great way to teach project teams how to collaborate while still allowing them to communicate in real time (Homayouni, Neff, and Dossick, 2010). BIM would also have a continuous feedback loop, ensuring that the project is optimised. This is similar to a "nutrient-absorbent tree that grows" (Kymmell, 2008).

Many factors have influenced BIM adoption, one of the most important being design process cooperation within the company. In the BIM design phase, a new workflow and design process are needed. Problems arise as a result of miscommunication and unsuccessful knowledge sharing or exchange within an organisation, which eventually leads to decision-

making failure, uncertainty, and dissonance (Aranda, Tasbihi, and Turner, 2015). Traditional two-dimensional (2D) designs were used in construction building projects until BIM was introduced to the industry. Humans need a great deal of expertise and experience to design and solve the problems that occur during the design process. This is time consuming, and the project is often beset by cost overruns (Ibrahim, Roy, Ahmed, and Imtiaz, 2010). CAD programmes were first implemented to speed up the design process, particularly when dealing with a large amount of design work or when clients often change their minds during the design phase. This was a significant improvement over manual design, but there seem to be ongoing issues with design changes, in which data was inconsistent, uncoordinated, and inaccurate among all stakeholders, with the added problem of software interoperability. However, BIM was introduced to the industry with the aim of addressing the collaboration issues that 2DCAD design created. However, due to BIM imposing a new workflow and design process for ensuring efficient collaborative work in a project, this progress has been minimal. BIM software systems, according to Scheer (2006) are considerably more complex than CAD tools. Manzione, Wyse, Owen, and Melhado (2011) point out that knowing four main tools, namely people, processes, technology, and information, will help to develop BIM technology and the collaborative work needed to use it. However, there has not been enough research done on this.

Barrier of BIM Collaborative Design

There is often an adjustment period when introducing a new technology. In the adoption process, however, the desire to adopt still comes first (Nikas, Poulymenakou, and Kriaris (2006) 16). According to Nikas et al. (2006), companies that are comfortable with proprietary systems and have an established IT infrastructure are more eager to implement collaborative technologies. However, it is important to remember that critical factors in adopting BIM applications include not only people's attitudes toward technology, industry and project characteristics, and individual resistance to change, but also the interoperability problem that arises after the implementation of new technology in an enterprise.

Interoperability

Interoperability refers to the capacity to manage and communicate electronic data between owners, clients, contractors, and suppliers, as well as between the design, engineering, operations, project management, construction, financial, and legal units of a project (Oraee et al., 2019). Interoperability is enabled by a variety of information technology tools and applications, including computer-aided design (CADD), three- and four-dimensional visualisation and modelling programmes, laser scanning, cost estimation and scheduling tools, and material tracking tools (NAP, 2009).

New Model of Collaboration

According to Hedges and Denzer (2008), the BIM approach has the ability to promote new models of student teamwork collaboration. Students who preferred a collaborative architecture approach that included real-time simultaneous interaction had a higher degree of conceptual sophistication and refinement, according to the researchers. In an open-ended design course where problems necessitate team cooperation, higher intellectual cognitive activity is essential.

Technologies Adoption

The implementation of new technology, such as BIM technologies, is time-consuming and expensive due to the need for training and the need to change workflows and work processes. When it comes to software and hardware, the initial training costs and productivity losses typically outweigh the initial investment. Often, most service providers are unwilling to make such an investment unless they believe it will benefit their own organisation in the long run and/or unless the owner subsidises the costs of training (Hammad and Abu-Hijleh, 2010).

Potential Improvement on BIM Collaborative Design

BIM implementation requires the adoption of protocols that develop a consistent understanding and view of project delivery procedures, as well as improving the accuracy and quality of BIM knowledge and deliverables to all stakeholders that are affected by the project (Kassem, Iqbal, Kelly, Lockley, and Dawood, 2014). To increase collaboration among themselves, professionals in the construction business have developed a range of solutions or tactics that have proven to be effective.

BIM Model Sharing

BIM Model Sharing is a knowledge model that is used for reporting, collaboration, and high-end rendering with the project team and other models. It allows project participants to use a BIM model outside of its original modelling environment. According to Azhar, Nadeem, Mok, and Leung (2008), several different types of software are used to create Building Information Models, but the most common are Autodesk Revit, Graphisoft Constructor, and Bentley Architecture. For instance, a Revit model can integrate with other software for simulation or different analyses (Hashim et al., 2021).

BIM Design Coordination

BIM design collaboration is a method or process used in the construction industry to establish a shared work environment and overcome reciprocal dependencies (Khanzode, Fischer, and Reed, 2008). The architecture consultant and subcontractors obtained a simple architectural model from the Owner's consultant. The structural engineer set up a collaboration framework after connecting the basic model. The structural engineer used Revit's "Copy/Monitor" tool to distinguish the improvements made by the architect to his model and vice versa. When a project team member sent an updated file, Revit automatically updated the path to that file. The principal consultant imported all of the discipline-specific models into Navisworks, and clashes were discovered using Navisworks' Clash Detective feature. The method was repeated as many times as necessary until all important conflicts were resolved. After recording the mechanical and plumbing plans in 2D CAD, they were subsequently modelled in 3D, with the 2D designs serving as a base for the 3D models. In order to give the design team with 3D model interoperability, Navisworks was implemented as a key goal. The project team used an iterative procedure to calculate the small size design brake-ups in order to assess constructability and execute clash detection on the smaller designs.

Industry Foundation Classes (IFC)

The Industry Foundation Classes (IFC) specification for building information modelling (BIM) has gained considerable adoption within the construction industry since it was endorsed by about 150 registered software programmes. Building knowledge can be applied across applications within and between vertical industries, and IFC's aim has always been to explain how this information may be applied to the diverse variety of disciplines found in the construction industry (Chipman, 2012). Apart from that, such standards are working on collecting the necessary detail to explain how a structure will be erected, in addition to the other non-physical features that explain who will do what and where and how and why.

Integrated Project Delivery (IPD)

IPD software allows for a degree of collaboration that not only increases performance and eliminates mistakes, but also allows for the discovery of alternative approaches (Porwal and Hewage, 2013). IPD has emerged as a distribution mechanism that could most efficiently promote the use of BIM for construction projects, among other things. However, the public sector is currently unprepared in terms of product, operation, and personnel to elevate BIM adoption to the level of IPD. When it comes to implementing IPD, there are certain limitations and challenges. Traditional leadership, obligation, and opportunity are common in the construction industry, and change is typically slow. Two significant roadblocks to full adoption are the lack of standard BIM contract documents and problems with using BIM as a collaboration system. Developing a value-based procurement strategy is difficult, particularly for public sector clients who are limited to evaluating competitive bids solely on the basis of the low-bid award scheme. Alternatives for public institutions and agencies to restructure their procurement processes to enable the IPD model are limited.

METHODOLOGY

The qualitative method was chosen for data collection in this study. Merriam (2009) suggests that the qualitative method focuses on context, experience, and comprehension, as well as encouraging researchers to engage with individuals or groups who are knowledgeable about the researcher's needs (Parkinson and Drislane, 2011). In-depth interviews and exploratory expert interviews were used to perform this research. In-depth interviews enable interviewees to express their viewpoints on a subject while also allowing the interviewer to gain a better understanding of the interviewees' point of view (Henn, Weinstein, and Foard, 2006). There were five project managers in Kuala Lumpur interviewed for this report, all of them had previous experience with BIM design in their projects and were eager to contribute and provide information for the report. The respondents who agreed to provide information were given a date for an interview appointment. Open-ended questions were used to prepare the interview questions. A week before the interview, respondents received an email with a set of interview questions. The interviews were held in a secure, non-interrupted setting, such as a conference space, to ensure that the messages were conveyed clearly. Before the interview, permission to obtain a voice recording was obtained so that it could be used for transcript purposes. For the interviewee's convenience, the interview questions were kept short and simple.

In this study, snowball sampling and purposeful sampling methods were used. This is a non-probability sampling approach in which some subjects or variables from the study's title are deliberately chosen (De Vos, Strydom, Fouche, and Delport, 2005). Respondents in this study have prior BIM experience and are currently dedicated to BIM design. A few companies had been identified as potential respondents in this study and had been named. Furthermore, De Vos et al. (2005) describe snowball sampling as the collection of data from known individuals in order to gather information about other members of the population. Because of the small number of respondents in Malaysia, this method of research will provide valuable information about consultants' organisations that are dedicated to BIM. The information gathered was transcribed into text and organised so that unnecessary information was removed and a manageable and informative database was created. After all of the data had been reviewed and evaluated, the study used the content analysis tool. It aided in the comprehension of the discrepancies and similarities between various levels, as well as effective methods for improving the consistency and efficiency of the solutions. For better comprehension, the data was then reported in tables and clarified in text.

RESULTS AND DISCUSSION

Respondents' Background

There were five interviews (5) sessions were conducted with the respondents for this research. The selection of respondents is based on their designation in the company, year of experience in construction field and using BIM. Table 1 showed the background of the respondents.

Table 1. Respondents' Background

	R1	R2	R3	R4	R5
Position	**BIM Co-ordinator**	**BIM Co-ordinator**	**CEO**	**BIM Co-ordinator**	**HoD of Buildings Technologies**
Industry Experience	4	10	15	4	13
BIM Experience	4	6	10	2	7

R1 has worked in the construction sector for four years and has four years of BIM experience. R1's current role is that of a BIM coordinator, whose responsibilities include clash and interference checking as well as providing a full virtual file that aids in decision-making. R2 has ten years of experience in the building industry and is currently employed as a BIM supervisor. R2 has been working with BIM for 6 years and is in charge of monitoring for clashes and intervention. R3 has 15 years of experience in the building industry and is currently the company's CEO. R3 has been working with BIM for ten years and is responsible for monitoring consultant work and providing training to companies interested in implementing BIM. R4 has worked in the construction sector for four years and has two years of BIM experience. R4's new role is that of a BIM supervisor, who is in charge of monitoring for clashes and intervention. R5 has 13 years of experience in the construction industry and is currently the director of the Building Technologies Department. R5 has been working with BIM for 7 years and is in charge of project monitoring and coordination. All the respondents are in charge of overseeing activities during the project design stage, and most of the BIM projects they have completed are residential and commercial buildings.

Barriers in BIM Collaborative Design

As part of the interview, the participants identified four challenges that are typically encountered throughout the project design stage, which were as follows: modifications in design; clashes in design; communication amongst designers; and adoption of new technologies. Taking a look at Table 2, all of the respondents felt that miscommunication between designers is the most difficult aspect of the job because everyone has their own thinking and is sometimes hesitant to change (Memon, Rahman, and Memon) (2014). According to R1,

> *"There are a few problems that we faced in our previous projects. The major issue is the miscommunication between designers. The issue can cause by design changes from the client and finally lead to design clashes."*

Table 2. Barriers of BIM Collaborative Design in Design Process

No.	Barriers	Respondents				
		R1	R2	R3	R4	R5
1	Design Changes	√	√	√	√	√
2	Design Clashes	√	√	√	√	√
3	Miscommunication between Designers	√	√	√	√	√
4	Technologies Adoption		√	√		

The miscommunication issue that occurred during the project design stage was acknowledged by all of the respondents. According to Baharom, Abdullah Habib, and Sapian (2021), effective communication is the most important factor in ensuring project success in a BIM-enabled environment. The client's requirements necessitate the need for design modifications. A client has made numerous amendments and changes to the project design, according to reports R2 and R3. The client's request must be accommodated during the project design phase of the project. Because of the client's changes of heart and amendments to the project design, the project design stage can sometimes be extended. According to Eastman, Teicholz, Sacks, and Liston (2011), the impact of design changes made by the client will result in the project's completion date being delayed. R3 had previously said,

> *"The communication and collaboration among the designers are important as there is the only way to deliver information from client. Sometime, disputes occur because of the amendment due to design clashes."*

R2 added,

> *"Redesign will consume most of the time in project design stage."*

Furthermore, design changes among designers will invariably result in design clashes in the long term. According to R4 and R5, design clashes occurred as a result of a lack of communication and collaboration among construction players, particularly structural and mechanical, electrical, and plumbing engineering (MEP) designers, who each prepare their drawings separately. As a result, according to the responses, coordination and cooperation between construction players are critical because it leads to inconsistent and uncoordinated project design. These issues, according to Eastman et al. (2011), would eventually lead to

design clashes. Furthermore, R2 and R3 emphasise another topic in the project design stage: technology adoption. Designers' reluctance to implement BIM technologies is creating issues in the early stages of project design. Furthermore, according to Stewart, Mohamed, and Marosszeky (2004), Malaysians are content with their current lifestyles and are hesitant to adapt. Since technology adoption necessitates the purchase of software and hardware, it is difficult to overcome the obstacles. Contractors may need time to realise the benefits of BIM. R3 went on to say,

> *"There still have who stayed comfortable with the conventional way strongly despise change."*

Improvement on BIM Collaborative Design

The potential improvements are ways to improve the barriers and issues faced in project design stage as illustrated in Table 3. Respondents had revealed four (4) suggestions provided by respondents that all the suggestions come from the approaches taken by Architecture, Engineering, and Construction (AEC) industry in improving the BIM collaborative design in projects.

Table 3. Potential improvement on BIM Collaborative Design

No.	Potential Improvement	Respondents				
		R1	R2	R3	R4	R5
1	File Naming Convention		√	√		√
2	BIM Design Coordination	√	√	√	√	√
3	Training and Learning		√	√	√	√
4	Enforcement by Government	√	√	√	√	

According to Table 3, in their interviews, all respondents discussed BIM design coordination. BIM design collaboration is a method or process used in the construction industry to establish a shared work environment and overcome reciprocal dependencies (Khanzode, Fischer, and Reed, 2008). Contractors can connect the basic model and create a collaborative work environment, according to Khanzode et al. (2008). Contractors are needed to build an online place or storage that can collect and handle the information given by designers during the construction design process by linking the model (Onungwa, Olugu-Uduma, and Shelden, 2021). Any changes files from project team members will automatically update the connection to that model after the models are connected (Autodesk, 2008). It is essential in the BIM design phase because it improves project team coordination by providing or exchanging important information with other project players. R1 claims that,

> "*In our company, eCOMS are the cloud based we chose to collaborate with other designers and A360 are used to share with construction players in the construction project*."

R4 added,

> "*As for models, internally, the BIM department uses a different server to store all the models."*

In BIM design coordination, respondents revealed that the linking process of model is important as it is an essential process to create a collaboration work environment in a construction project. The company's servers, which were created to connect the models, are used to manage and exchange information among the construction players (Onungwa et al., 2021). The information in the shared area is carefully handled by the BIM manager to ensure that it is accessible to all parties. R5 remarked,

> "*Design teams and other project contributors are able to work their own 'Work in Progress' areas*"

> Furthermore, R2 stated that, "*Any information changes will have to approve by the originator before it moves to the shared area for other parties to access"*

According to BS 1192:2007 (2016), the organisation is responsible for the quality of the Work in Progress (WIP) information and should ensure that suitable checking and review processes are in place. The Popular Data 40 Environment (CDE) WIP area is also known as a sharing space where members of project teams can execute their own work utilising their organization's systems, either the common repository or their own server as repository (BS 1192:2007, 2016). (BS 1192:2007, 2016). Beside than that, another potential enhancement to improve BIM collaborative design is file naming convention. It is a standard naming in every company to name the file and object in BIM NBS, 2016). All team members work to the same standards as one another to enhance the collaboration work environment within the project team. R2 elaborate,

> *"The naming of every folder is one of the essential parts in the construction project as it could convenient other members in the project teams to assess what they need in a short time*".

> Moreover, R5 added, *"In industry there is a certain naming convention software that automatic they will name the folder, but sometime the naming convention does not tie to any CDE tools and we have to name it ourselves".*

Model file names should be named according to seven (7) fields, according to [34], which are project, originator code, Zone/System, Level, Sort, Function, and Description. To organise team operation and avoid inadvertent changes in the output documents, conventions in the naming and use of views are required. The naming of model file sharing, library object naming, and display naming are the three main file naming standards of naming convention [32]. The following fields are included in the model file sharing naming: (1) Project, (2) Originator, (3) Zone/ Framework, (4) Level, (5) Sort, (6) Position, and (7) Definition. For example, the file name "FTR-ACM-XX-XX-M3-S School Stage E.rvt" stands for "acme structures model for School project at Stage E – no zones or floor segregation." Furthermore, view naming is the use of views in a project to organise team operation and avoid inadvertent changes in the production documents (AEC, UK, 2012). The project's view naming must be consistent with all references to that view. Renaming views should be done with caution because any modifications would be replicated in all documents. According to respondents, having a naming standard in a design team is relevant because it facilitates teamwork in construction projects. Apart from that, R2, R3, R4, and R5 stressed that offering training and learning to develop their skills and expertise is the best way to improve project design

collaboration work. The training and seminar will help construction professionals advance in their careers and gain knowledge of how to use BIM in their projects (Zakaria, Ali, Haron, Marshall-Ponting, and Abd Hamid, 2013). R3 elaborated,

> "*Training will not only improve their personal knowledge about BIM, it also motivates construction players on the benefits of BIM in construction project."*

The knowledge sharing in the seminars conducted by experts, according to respondents, would also provide a guidance for participants in the construction industry on the process that includes BIM in the project. According to Pena (2011), design firms only train employees to use BIM tools in the workplace. BIM design technicians, BIM administrators, and other users with roles solely related to the BIM environment are among the office users. On the other hand, the AEC industry may need to train field staff who are unfamiliar with BIM software, which is commonly used only infrequently in the field (Oraee et al., 2021). Training should begin with the BIM manager and a small group of BIM design technicians in order to promote implementation in the office (Green, 2007). The training should not just focus on learning new software, but also on how the software interacts with building industry processes (Mohd Fateh & Abdul Aziz, 2021). Workers' skills in using BIM technology increase as a result of the company's training and education, as well as their experience and interest in using BIM technology to design a construction project.

Besides that, R1, R2, R3, and R4 agreed that government regulation is one of the possible changes that can help to boost design collaboration work. To increase BIM adoption in the Malaysian construction industry, the government must undertake some initiatives to raise BIM awareness among construction firms. According to CREAM (2014), the government's enforcement of BIM implementation will aid in the improvement of BIM practises among construction project participants. The methods are supported by respondents because the government should provide training and guidelines for the AEC industry to improve their BIM awareness. R2 stated that in this method,

> "*Government can enforce the construction company that register under CIDB Malaysia to attend the training provide by CIDB to increase the awareness of BIM in Malaysia construction industry*."

R4 added,

> "*Government could provide a standardise BIM guideline for construction company in Malaysia*"

According to Zuhairi et al. (2014), government support and regulation of BIM implementation is critical in the BIM adoption in the Malaysian construction industry. Strong government support, such as offering a BIM programme to train construction firms, would enable contractors in Malaysia to learn about BIM technology. Government compliance, such as mandating the use of BIM as part of their strategy and contract terms, would improve BIM adoption in the construction industry (Zuhairi et al., 2014; Oraee et al., 2021).

CONCLUSION

The study's objectives were successfully carried out and accomplished, and the data obtained from respondents in the interviews. The study found that the key issue with BIM collaborative design is cooperation between construction players. Every group in a construction project has their own mentality, however, there are a few potential changes in the building sector that could solve barriers and improve BIM collaborative design. Respondents in the interview are able to share their BIM perspectives and knowledge, which will aid in the completion of this report. The findings of this study led to the following recommendations for future researchers and the construction industry; to provide more training to enhance the awareness and experiences of construction players on the BIM process, technology, and equipment. In addition, to increase the use of BIM in the Malaysian construction industry by improving the construction industry's attitude on the benefits of BIM.

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DEVELOPING THE PERFORMANCE AUDIT ENVIRONMENT WITH THE INTERVENTION OF INFORMATION TECHNOLOGY IN OMAN PUBLIC SECTOR

Mohammed Hamed Al-Salmi[1], Seow Ta Wee[1,2] and Fazal Akbar[3]
[1]Department of Construction Management, Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Malaysia.
[2]Center of Sustainable Infrastructure & Environmental Management (CSIEM), Faculty of Technology Management & Business, Universiti Tun Hussein Onn Malaysia, Parit Raja Malaysia.
[3]Department of Business Administration, University of Buner, KP Pakistan.

Abstract
The use of information technology in management systems in Oman, such as e-government, e-service, e-payment, and e-education, has recently improved. The Omani environment for performing audits is still developing. Today, leveraging information technology to improve the audit performance environment has become an essential and anticipated topic in the audit field. Although audit performance improvement is a sort of audit that focuses on analysing the efficacy of internal and external economics, it is not distinctive from finance audit in any way. This paper intends to analyse if information technology may help the Oman public sector achieve its organizational goals in an environment where audit performance can be improved. Additionally, this study used software analysis (PLS) and (SPSS) methods to investigate the connections between information technology and audit performance. The findings revealed a considerable and favourable association between information technology and environments that enhance audit performance.

Keywords: *Audit environment; audit in Oman; audit, responsibility of audit; information technology; benefits of information technology.*

INTRODUCTION

The audit is perhaps the most frequently used tool in every company since it helps to safeguard it against both internal and external influences, keeping it on the safe side. The audit oversees both the organizational and financial aspects. The audit section has one additional key component that makes the audit more necessary for the company to achieve its goals in a cost-effective and high-quality manner, including organization operation optimization. By applying a methodical, disciplined approach to assessing and enhancing the efficacy of risk management, control, and governance procedures, it aids a company in achieving its goals. A properly executed audit should also highlight any flaws, strengths, or shortcomings in the organization's internal control system. According to Hamzah et al. (2019), that internal audit and internal control had a considerable favourable association.

Internal auditing processes outline the steps that firms should take to prevent fraud, corruption, forgeries, and bribes. Regular employees who are part of the company internal audit department conduct internal audits. They have an internal audit as their major responsibility. An internal audit is carried out in this instance while the employee is working. Additionally, experts from the certifying authority or consulting firm undertake an internal audit. In other words, external professionals from certification agencies or consulting firms are totally entrusted the responsibility of internal audits. On the audit task, specialized staff conducts an internal audit. The top management of the company, the shareholders, or the

owners of the company choose the internal auditors. Employees perform an audit outside of work as part of the internal audit (Singh et al., 2015).

Internal audit is enhancing organizational performance more by concentrating on the management and finance departments. In order to regulate the organization's financial process circles, internal audit is researched in finance theory. A private company also requires an internal audit to verify its financial records, management procedures, financial records, financial operations, and compliance with applicable laws and regulations (Dimitrova, 2014).

LITERATURE REVIEW

Audit Environment

The Latin term audire, from which the English word audit is derived, implies to listen and inform. According to the tasks and requirements of the company, an audit is one of the processes that has the scope of controlling and auditing financial documents. In essence, the audit also assesses financial feedback data to support organizational goals. In order to safeguard the company from internal and external effects, the audit also focuses on verifying and reviewing the procedure to assess the financial and audit job. One of the audits provides top management with improved recommendations to address issues (Karim et al., 2022).

A few steps in several categories, such as the management process, financial process, operational audits, projects process, and audit process field, are devoted to obtaining organization norms and regulations. Environmental audit is defined as "an indicator of management involves the field of systematic, evidence-based, decadal, and objective examination of all activities of the enterprise in relation to the environment, management readiness, and compliance of all other business conditions with prerequisites of the established environmental policy and is premised on the three approaches and practical needs" (Ljubisavljević, 2017).

The audit environment has spread throughout many industries, including the public and commercial sectors. The auditing profession is a procedure designed to safeguard organizations against bribery, mental fraud, document forgery, and corruption. The organization is protected from financial danger thanks to audit, which also helps manage risk. To make goals and attain accomplishments in the audit industry, the organization must adhere to certain tool practices and policies (Agyei-Mensah, B. K., 2018).

Historical Perspective of Audits in Oman

Since Oman adopted Islam, the audit has long since passed. Omar bin Al-Khattab was in power at the time. Concern was raised about Baeet Almaal (Muslims House Monetary), which was at 634 million. The Baeet AL-Maal work of Muslim covered the audit area. Therefore, the audit was split into two sections: management and investments were the second section, and the first section dealt with money. The highest authority in the Omani State, the Imam, who is also the head of government, received a direct report from the audit. However, everything was manually audited in the past, from records to investigations. Additionally, that only applied to the public sector and wasn't for the private. Abd and Jafer bin Al-Jalandi, the first imam, formed Baeet Almaal (Muslims House Monetary) in Oman. He then organized

the Baeet Almaal organization in the manner of Omar Al-Khattab. Therefore, in this arrangement, the audit involved higher authority monitoring the management and finances. Since the audit was given the term (Al-Hassban), which meaning auditing team, the auditors are only chosen after reporting to the Imam (Ahmed Alsaiabi, 2018).

The assumption of officials and personnel in this hazardous apparatus must be looked at by the audit. The audit in Beat ALMaal (Al-Hassban) has some classification named as (Al-Hassban/ALnazer/ALShahad) and their duties including such, the witness's (auditor's) mission is to control everything he witnessed in him, the auditor's task is to look at the money, in which the accounting entries are presented to him to scrutinize and authenticate them, so he authorises the What is the right and decides and what Annual management and financial reports with recommendations are given to the Imam (higher authority). That suggests that Islamic civilization has a great influence on both management and financial audits (Akloush Abdel Wahab, 2015).

Audit Responsibility

Driving the management and finances in accordance with organizational standards and financial legislation is the primary job of the audit department. Dealing in financial components is risky if there is finance involved. Generally speaking, the audit's duties include keeping an eye on financial statements and reporting to top management. Additionally, the audit's duties include verifying financial figures again, reporting to higher-ups in businesses, and looking into fraud, corruption, and document forgeries. Internal audits and external audits are the two categories under which audits are classified. They both have the same objectives but have slightly different responsibilities (Zager et al., 2016).

Internal Audit Responsibility

Internal auditing is only the duty of the organization's area, and it reports to the organization's leadership. Financial investments in stockholders or shareholders, management systems, information technology, the production sector, and commercial sectors are just a few of the ways that the economy is evolving. Recently, there has been a significant demand for internal audits to assess and submit findings to the public or higher-ups in the organization to safeguard it from internal consequences. Internal audits are primarily responsible for looking into the financial process, examining all financial organization activities, and taking appropriate action when there are financial concerns or potential financial theft (Drogalas et al., 2017).

Internal audit is required to be present in firms to investigate financial entries and financial exits in order to control finance activities and prevent fraud in financial transactions. The internal audit's unique characteristic is that it is conducted while compiling and documenting company activities (Axmedjanov K., 2020).

External Audit Responsibility

The focus of external audit duties is on both inside and outside the enterprises. Complementary to internal audit duties, but with greater scope and authority, are the responsibilities and tasks of external audit. External accountability protects businesses in both

the public and commercial sectors against fraud, corruption, falsified paperwork, and financial manipulation. Additionally, there are two components to external audits: external audit (government part) and external audit (private part) (agency audit). For financial and outside investment considerations, the external auditors must take into account all private organizations with investment shares (Kassem et al., 2016).

Additionally, the external audit's responsibilities include directing the public and private sectors to safe areas. The primary goals of external audits as a governance tool are to enhance and safeguard the financial information that businesses create in order to guarantee the accuracy and legitimacy of businesses reported financial statements in genuine transaction papers. Moreover, the external audit is also responsible for the private sectors, taking into account risk assessment and test for false claims, and reporting accordingly to the audit committee (Fossung et al., 2019).

Information Technology

Information technology is crucial for the advancement of the economy and quality of life. Information technology systems have grown in popularity and reliability since 1980. There are risks associated with employing information technology in general, but there are also solutions. The use of information technology has risen dramatically across a wide range of industries, including industry, management, the military, human services, and healthcare. Information technology is the most important factor in economic growth since it can transform corporate and governmental sectors to create better environments (Bessen J., 2017).

The research and manufacturing systems have found more fascinating themes in the information technology system (ITS). The acceptance or the first use of an emerging technology or product has been described as the advancement of information technology since it was first noted more than 40 years ago. Information technology also emphasizes the needs of people as their circumstances change. Additionally, there are more than 10 different fields and types of information technology, including automation, cloud computing, communications, infrastructure, machine learning, database management, analytic, artificial intelligence, communication, networks, cybersecurity, software development, and apparel (Salahshou et al., 2017).

Advantage of Information Technology

We will only highlight a few of the many advantages of information technology to human society that are related to economic advancement, such as:-

Time Saving

Information technology reduces the amount of time needed for manufacturing, management processes, telecom communications, the transmission of commercial papers, and business translations. The use of financial transaction statements, management advertising, and mobile apps for quick and simple communications are all examples of information technology (Hamidi H. et al., 2018).

Cost Efficient

Cost savings are one of information technology's key advantages. It is fostering fierce price competition, lowering manufacturing process costs, lowering management and financial process costs, and saving money throughout company transactions. Information technology brings everything close at hand and within reach (Chuang et al., 2016).

Communication Improvement

Modern communications are made simple and real-world through information technology, including social media, phone apps, internet use, paper trail documentation, management oversight, and video calls. Information technology is advancing communication systems to expand in business and human services. Information technology supports the continuation and improvement of education in challenging circumstances like natural disasters (Susanti S. et al., 2019).

Developed the Medical Environment and Reduced the Death Rate

Producing technologies and equipment that benefit individuals and improve the healthcare system through information technology platforms. Using information technology in the medical field can both save and give hope to other people's lives. Information technology is employed in the medical field for things like x-rays, procedures, bodily tests, and reporting. The ITS Business Continuity and Disaster Recovery program, primarily coordinates and oversees our ITS emergency management efforts, manages IT integration into the HICS (Grange et al., 2020).

RESEARCH DESIGN

This study took into account how the public sector of Oman's audit environment may function better by implementing information technology. There is a greater need for information technology utilization in research today. In this essay, the impact of information technology on audit performance in the public sector of Oman was analysed and examined, and their connection was looked into. The following are the study's suggested assumptions:

H: Information Technology influences on audit environment performance in Oman public sector.

Paper framework designed as shown in Figure 1 below:-

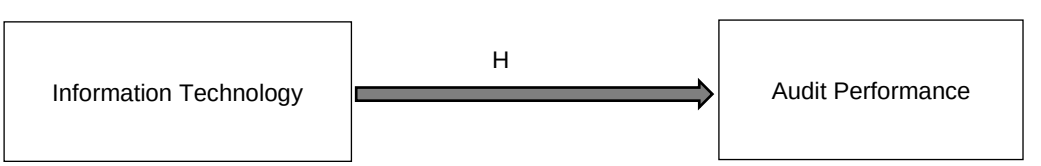

Figure 1. Research Framework

The Statistical Package for the Social Sciences (SPSS) and partial least squares (PLS) methodology were utilized in this study (SPSS). Additionally, questionnaires submitted to Oman's public sector internal auditors and utilised in this research (ministries internal auditors). The 5-Point Likert scale was also employed by us for the measuring items.

RESULT

In this study, we administered questionnaires to 280 auditors with a sample size of 166 internal auditors. 165 auditors responded to the call for information. Higher scores in the information technology replies to results (G.I.T. Q4) and nearly all of the items' scores between (1.59 and 1.81) indicated that the results fell within the expected range. Additionally, the audit performance response displays a range rate of (1.61 - 3.01) mean. In other measurement as Path coefficient score was (0.596), F-Square was (0.552), Cronbach score was (0.901), Collinearity statistic (VIF) between (1.103- 3.172), all factor loading achieved the target requirements as shows in this results that indicator loadings of information technology items were (G.I.T.Q1, G.I.T.Q2, G.I.T.Q3 G.I.T.Q4, G.I.T.Q5, and G.I.T.Q6) the score were 0.771, 0.800, 0.871, 0.846, O,843 and 0.772 respectively. Audit Performance is measured with six items as can be seen in Measurement. The indicator loadings for the Audit Performance construct items of (H.P.Q1, H.P.Q2, H.P.Q3, H.P.Q4, H.P.Q5, and H.P.Q6), the score is 0.687, 0.308, 0.691, 0.716, 0.755 and 0.815 respectively. Cronbach's Alpha measurement shows the result in Information Technology score value is (0.901) and, Audit Performance, score value is (0.765) met research requirement. Consequently, convergent validity and discriminant validity have been fitted to the research model. The P-value for the relationship is supported by the path coefficient recommendations and the absence of any problems between the components. The major relationships between information technology and audit performance were also examined in this article, and the findings indicate a favourable relationship between the two variables. In the end, implementing information technology also supports this notion regarding audit performance enhancement. The measurement and relationships between the variables in this research are as follows:

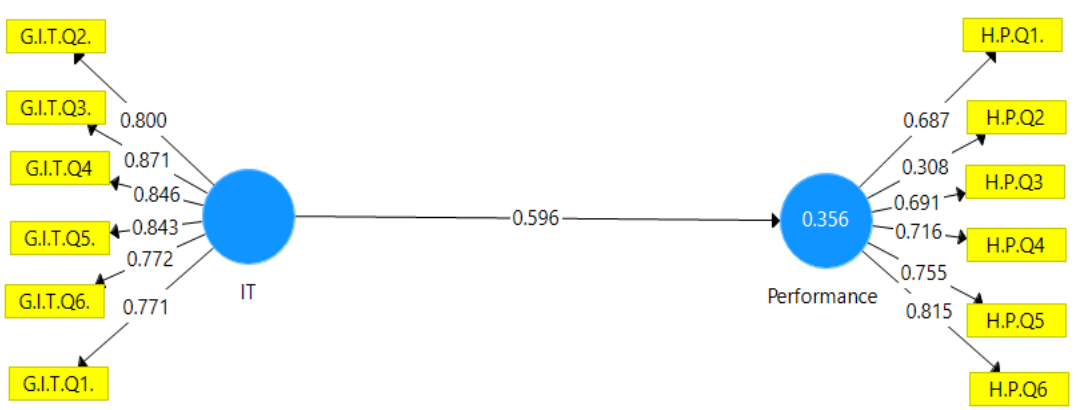

Figure 2. Research Measurement (Author)

CONCLUSION

In this study's analysis of the data, it was discovered that there is a strong and favourably correlated relationship between information technology and the environment for improving audit performance in the Oman public sector. According to the findings of this study and

earlier research, information technology plays a significant role in the development of the global economy. It is significant that audit performance in Oman improves as a result of using it, and there are numerous benefits for both the public and private sectors of the economy. These conclusions and findings were given in the final section of the report after meeting all the requirements. We must overcome a number of obstacles in order to implement the audit of the future. The first is to close the discrepancy between the new auditing method and the current auditing standards. The importance of auditing technology in financial statement audits is growing as a result of recent advancements and emerging technologies. On the other hand, increasing customer demands for innovation in auditing is pushing auditors to employ the same advances and technologies. Due to outside rules, up-front fees, and shifting skill requirements, this still presents some difficulties. However, the impact of using (or intending to employ) new technologies in the audit is already being felt thanks to favourable client feedback.

RECOMMENDATION

Based on the current research conducted in Oman public sector, we highlighted the following points:

- Make campaigns to raise awareness of the usage of technology in audits.
- Hold workshops to teach auditors how to use audit software by utilizing examples from real-world situations.
- Learn from the expertise of various top audit institutions regarding software and information system audits.
- Email or training sessions can be used to communicate peer reviews and experiences with State Audit Bureau staff.
- To enable staff members to put what they learn in training courses into practice and raise the calibre of audits, which will be reflected in reporting, the State Audit Bureau must provide auditing software or several software.
- Encourage employees to use information technology because the future is digital.
- Create a methodology for auditing that supports information system audits. Develop a framework that will guide auditors through all audit phases while employing information systems to audit.

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THE CRITERIA OF RAILWAY STATION IN MALAYSIA: THE MEASUREMENT OF ACCESSIBILITY IN FACILITIES MANAGEMENT (FM) PERSPECTIVE USING FM-ANP IN KLANG VALLEY, MALAYSIA

Hasniza M. Yusoff[1], Edie Ezwan Mohd Safian[1], Azlina Md. Yassin[1] and Kamalludin Bilal[2]
[1]Department of Real Estate Management, Faculty of Technology Management & Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Johor, Malaysia.
[2]Lotus Design and Services, 50 Jalan Hijau 2, Taman Pulai Hijauan, Kangkar Pulai, Johor, Malaysia.

Abstract
Numerous rail systems, including *Keretapi Tanah Melayu* (KTM), Light Rail Transit (LRT), Mass Rapid Transit (MRT), Express Rail Link (ERL), and KL Monorail in the Klang Valley, have been developed in Malaysia as a result of the country's rapid growth of railway technology. Unfortunately, the lack of amenities at the Klang Valley railway station—including those for safety and security, upkeep, comfort, physical facilities, accessibility, environment, communication, and more—leads users to choose their private vehicles as a daily mode of transportation, which adds to the region's traffic congestion. This study's goal is to evaluate the Klang Valley railway station's accessibility in terms of Facilities Management (FM), utilising criteria that are unique to FM and are focused on people, places, processes, and technology in addition to accessibility criteria. Therefore, it is suggested that this article evaluate the accessibility of railway stations using the integration of FM and Analytical Network Process (ANP) in a thorough manner, and then rank these criteria by utilising the actual analysis. In light of FM and accessibility, the results will provide the ranking that has the greatest impact on users' decisions to use the railway as a mode of daily transportation. In order for Malaysia to compete internationally, it is envisaged that this research will provide stakeholders with ideas for increasing the quality of railway stations in terms of facilities, accessibility, and connectivity. Finally, by enhancing the amenities at the train station, more people will be enticed to use it, which will help to ease traffic congestion in the Klang Valley in the future.

Keywords: *Railway station; accessibility; Facilities Management; Analytical Network Process (ANP).*

INTRODUCTION

Accessibility is essentially the capacity to reach particular locations. Several studies have incorporated the social and economic factors into this notion, supporting accessible viewpoints such as the benefits of a specific location from the population on using the transportation system (Perez, 2011). A site with good accessibility can draw in more business; because accessibility elevates a location's prominence, this is most significant for areas close to transportation hubs with excellent connections, including high-speed rail service (Willigers & Van Wee, 2011).

Numerous scholars in the field of public transportation need to approach certain criteria from a different angle. Some of the most important factors for both an efficient transport system and the comfort of passengers are facilities for passengers in stations and stops. The variety of necessary accessories depends on a wide range of external factors that may be constant over time or fluctuate. Station amenities include ticket booths, private waiting places, spots for quick waits, rest areas, shops, and other supplemental commercial pursuits (Havlena et al., 2014).

According to Yaakub and Napiah (2011), it is necessary to evaluate the users' perspective of the public transportation service in order to identify the pleasant appearance of the service in terms of availability, comfort, and convenience. In light of this, Suria's nine elements for railway facilities from 2016 were selected, including accessibility, dependability, responsiveness, physical facilities, safety and security, understanding, environment, time, and fare. Numerous studies have merged social and economic factors into this term, supporting the idea that accessibility refers to the benefits that the people in a certain area derive from using the transportation system (Kido, 2011; Lopez, 2007).

Typically, accessibility is described as the ability to physically access goods, services, and locations. The ease of access to a given place or site is defined as accessibility, one of the most important outcomes of the transportation system, in the context of urban economics and geography (Mavoa et al., 2012). It measures the advantage of the place over competing locations (Biosca & Stepniak, 2013). Easy access to public transit improves accessibility to other services (Abreha, 2007; Saif et al., 2019).

Therefore, in order to create a location or public transport of higher access to a location, there is a need for a wide range of criteria from the facilities management view by public transport providers to meet consumer needs and requirements for becoming more efficient and user-friendly. In order to address this, a model has been developed to gauge the criteria from the point of FM-ANP as discussed in this article.

The Weightage of Railway Station Criteria Importance in Accessibility through Facilities Management Perspective using FM-ANP

The weighted importance of each FM criterion must be examined in order to determine their significance for accessibility, notably in Malaysia. The Analytical Network Process (ANP), a novel approach to decision-making analysis, serves as the foundation for the measurement of important weighting. ANP has gained a lot of popularity in research since it differs from other approaches by using problem-solving and weightage computation instead of conventional instruments.

ANP begins by seeking dependencies in the network. This is done by scanning all elements in all clusters and finding if the elements affect other elements in relation to the specified control criteria. Afterward, the element in a cluster that influences an element will be pairwise compared to the control criteria using the same method and scale used in AHP (Saaty, 2016).

According to Satty (2008), a method of dissecting outcomes through the following processes is necessary to provide an organised result to generate each importance or priority:

- Identify issues and decide on the various components or standards.
- Establish objectives decision, objectives from a single perspective via levels of medium (criteria and sub-criteria), and for the lowest stage in the decision hierarchy (usually in an alternative phase).
- Create a matrix-based framework for pairwise comparisons. There will be some comparisons between some of the criteria for each group and level.

- Taking into account any such interest in the form of a preferred ranking using the interest that has been discovered via the comparison (weightage of importance).

In this study, the FM-ANP approach will be used with the ANP method to assess the significance of Klang Valley railway station accessibility from an FM perspective. In order to determine the importance of each of the FM-criterion and sub-criteria, the variables set in this research—People, Place, Process, Technology, and Accessibility—will be compared to one another. If each of the FM criteria has a sub-criteria, then a similar comparison must be made.

FINDINGS AND CONCLUSION

There are five research areas that have been chosen in the area of the railway station in Kuala Lumpur. This consists of the area in Klang Valley (KV) which is Putrajaya Station (ERL), Chow Kit Station (KLM), Subang Jaya Station (KTM), Bandar Tun Hussein Onn (MRT), and Hang Tuah Station (LRT). Table 1 indicates a summary of the sample involved, including the sample of FM-ANP and the sample of respondents (users) in the research survey that corresponds to each technique adopted in the research.

Table 1. Distribution of Samples for Survey on the Importance of Railway Station Accessibility Criteria of FM-ANP in Klang Valley

Sampling Techniques	Railway Stations		Occupants of Railway Station Users (Respondents)		Total
	Cluster Sampling		*Non-Probability Sampling (Quota Sampling)*		
Railway Stations in Klang Valley	**Unit**	**Sample Size**	**No. of Occupant (Unknown)**	**Samples of Occupant**	
Putrajaya Station (ERL)	10	10		10	100
Chow Kit Station (KLM)	10	10	-	10	100
Subang Jaya Station (KTM)	10	8	-	10	80
Bandar Tun Hussein Onn (MRT)	10	7	-	10	70
Hang Tuah Station (LRT)	10	8	-	10	80
Total		33			330

Figure 1 and Table 2 show the final findings for the weightage of railway station criteria importance in accessibility through FM perspective. These findings are final after taking into account the Eigenvalue and also the consistency ratio needed to get the weightage of importance through this ANP analysis. Through these findings, it is easy to compare with other researched areas on the importance of FM criteria for railway station accessibility at each stated level.

Figure 1. Railway Accessibility in Facilities Management (FM) Using FM-ANP Model

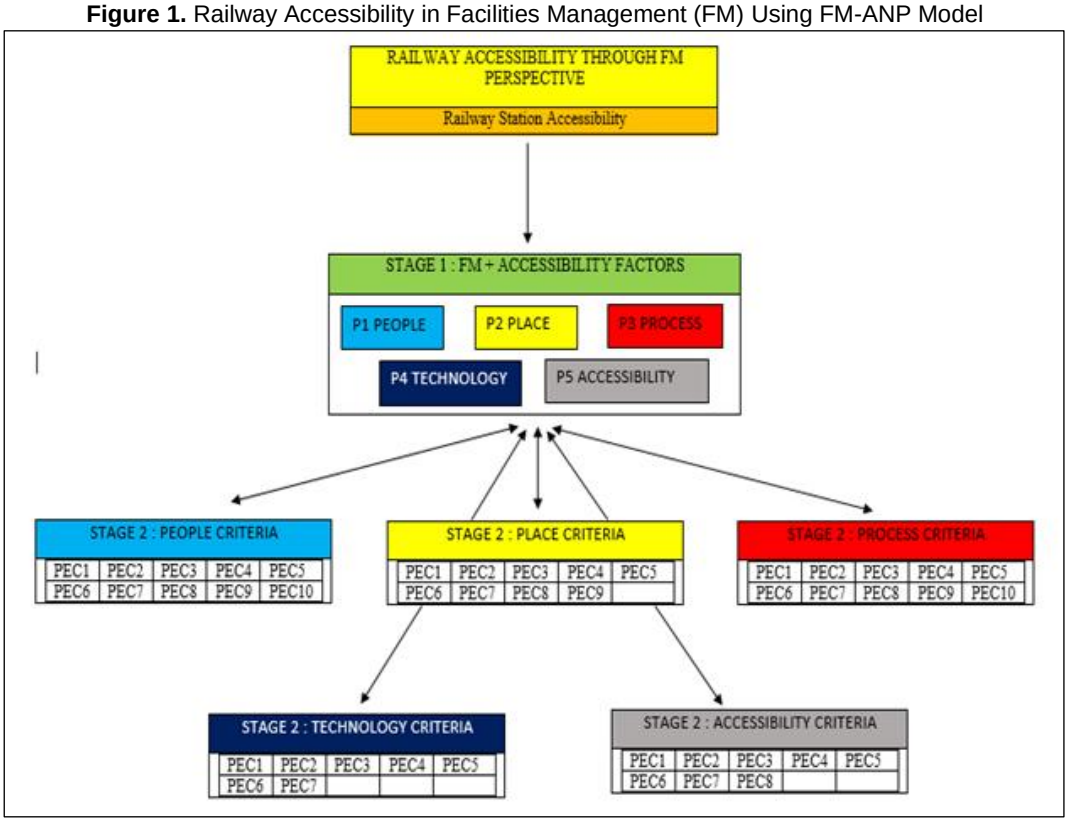

Table 2. Weightage of Railway Station Criteria Importance in Accessibility Through Facilities Management Perspective Using FM-ANP in Klang Valley

CODE	FM CRITERIA	ERL	KLM	KTM	LRT	MRT
	PEOPLE	0.019018	0.058311	0.030682	0.030682	0.063895
PEC1	Empathy / assurance	0.012813	0.009804	0.010475	0.010475	0.011070
PEC2	Environment	0.026697	0.013225	0.019261	0.019261	0.066805
PEC3	Tangibility	0.031017	0.010671	0.008821	0.008821	0.016766
PEC4	Safety & security	0.104489	0.115467	0.083456	0.083456	0.084191
PEC5	Culture	0.019631	0.018752	0.018956	0.018956	0.068331
PEC6	Staff behaviour / Driver behaviour	0.058187	0.030462	0.046562	0.046562	0.064218
PEC7	Operation / technical element during operation	0.087348	0.073406	0.049847	0.049547	0.034473
PEC8	Comfort / cleanliness / case of coach	0.677319	0.134784	0.098028	0.098028	0083186
PEC9	Understanding / knowing customer	0.046457	0.064244	0.120118	0.120118	0.052420
PEC10	Policies	0.036043	0.029184	0.044477	0.044477	0.018441
	PLACES	0.192673	0.035648	0.266159	0.266159	0.024329
PL1	Accessibility	0.041029	0.023990	0.055764	0.055704	0.039355
PL2	Environment	0.035055	0.008393	0.038317	0.0638317	0.035769
PL3	Railway facilities / station facilities / physical facilities	0.099212	0.111233	0.060275	0.060275	0.099964

CODE	FM CRITERIA	ERL	KLM	KTM	LRT	MRT
PL4	Tangibility	0.097440	0.011873	0.020911	0.020911	0.016030
PL5	Urban renewal	0.026309	0.030905	0.042863	0.042863	0.050809
PL6	Competence	0.041855	0.008442	0.092742	0.092742	0.030846
PL7	Tickets offices / Tickets system	0.077657	0.046476	0.62953	0.062953	0.066741
PL8	Separate waiting areas / space criteria	0.057817	0.114539	0.065219	0.065219	0.080662
PL9	Refreshment point / stores / shop / convenience	0.023626	0.084149	0.060955	0.060955	0.080825
	PROCESS	0.086712	0.031399	0.018411	0.018411	0.023684
PR1	Safety & Security	0.127890	0.030254	0.027983	0.027983	0.107830
PR2	Information provision / communication	0.026579	0.023376	0.012678	0.012678	0.016861
PR3	Efficiency / frequency of train	0.671003	0.057221	0.048872	0.048872	0.041577
PR4	Various bus / changes & interchanges between moves or transit of train	0.062494	0.067674	0.050840	0.650840	0.051719
PR5	Reliability	0.035193	0.030852	0.019599	0.019599	0.015705
PR6	Comfort / cleanliness / case of coach	0.038477	0.094998	0.087703	0.087703	0.096809
PR7	Railway facilities / station facilities / physical facilities	0.032035	0.072916	0.069886	0.069886	0.074335
PR8	Responsiveness	0.056605	0.042330	0.058942	0.058942	0.027015
PR9	Competence	0.022414	0.038840	0.061278	0.0612278	0.025621
PR10	Operation / technical element during operation	0.027311	0.041540	0.062217	0.062217	0.042527
	TECHNOLOGY	0.072785	0.210809	0.068021	0.068021	0.272646
TH1	Information provision / communication	0.030968	0.047695	0.033917	0.033917	0.110843
TH2	Safety & security	0.211592	0.072354	0.082738	0.082738	0.079367
TH3	Reliability	0.036299	0.030556	0.030023	0.039923	0.053864
TH4	Marketing & promotion	0.028605	0.061375	0.045941	0.045941	0.023360
TH5	Tickets offices / tickets system	0.086441	0.057456	0.082714	0.082714	0.066197
TH6	Separate waiting areas / space criteria	0.03896	0.117767	0.077541	0.077541	0.111416
TH7	Various bus / changes & interchanges between moves / transit	0.067133	0.112797	0.147126	0.147126	0.054952
	ACCESSIBILITY	0.128813	0.163833	0.116727	0.116727	0.115436
AC1	Distance of residential area	0.070611	0.040799	0.111881	0.111881	0.108201
AC2	Distance of public transportation	0.057425	0.068480	0.060551	0.060551	0.037540
AC3	Distance of commercial area features	0.054592	0.051025	0.031286	0.031289	0.024828
AC4	Distance to the utilities	0.060302	0.071539	0.043666	0.043666	0.061857
AC5	Distance to the recreation	0.052306	0.045643	0.013452	0.013452	0.112444
AC6	Availability of transportation options	0.073425	0.077727	0.093243	0.093243	0.038702
AC7	Pedestrian and vehicle flow	0.057811	0.045493	0.079681	0.079681	0.040560
AC8	Availability of disability people	0.073528	0.099294	0.066241	0.066241	0.075867

The ANP technique has created a value of weightage of relevance based on each FM criterion based on Table 2's data. According to each FM criterion, the weightage of importance value developed can be ranked in a separate group. Other than ANP, decision-making techniques had been used in prior research. For instance, Suria's (2016) TRANSQUAL Model, which provided a ranking of the value of importance in a holistic method to get all parameters of railway station service quality in FM, was used as a tool to measure the performance of rail transportation. The results showed that the KTM service quality indicators were broken down into five categories: environment, safety and security, reliability, responsiveness, and physical facilities, while the LRT indicators were broken down into environment, physical facilities, accessibility, reliability, safety, and security. As a result, these variables can be used to gauge how well the service is performing and to determine how appealing public transit systems are. The researchers won't be able to determine the value of weightage of importance in a more precise manner according to groups if the approach is used in this study. This is so because each FM-ANP criterion is in its own cluster and has a unique purpose. This point has been demonstrated by study conducted by Ho et al. (2005), who used the AHP approach and grouped all of their criteria into six groups according to the value of each individual criterion that was discovered on each group. Then, using the same procedure and scale as in AHP, the element in an ANP cluster that affects an element will be compared pairwise to the control criterion (Saaty, 2016). Through indirect means, the ANP approach utilised in this study was able to determine the value of weightage of importance for each FM-ANP criterion in a more precise manner. The degree of weightage of importance on each produced FM-ANP criterion is slightly different based on the study findings using the ANP approach than other similar research that has been conducted in the past.

As a result, based on the difficulties of the researchers to get in touch and get a list of the accessibility criteria in FM perspective on each FM-ANP method compiled in one survey question for this research, the researchers chose the user randomly on each FM-ANP sample at a selected railway station. This research is supported by previous research done by Suria (2015) that chose railway users as respondents in examining the rail transport performance and similar to users of this research as the respondent to get the actual result of the inaccessibility of railway stations using FM-ANP method. This is indispensable in order to achieve the main objectives of this study, whereby it takes into account the measurement of the accessibility of the railway stations through facilities management perspective using FM-ANP respectively.

In the local context, unlike previous studies, this study focuses more on determining the level of importance of public transport services, especially for the accessibility of railway stations in the Klang Valley through the FM-ANP approach. The results of the study have proved that the criteria of accessibility factor to the railway station have become the main choice of consumers in the study area. This proves that accessibility infrastructure should be emphasized at every railway station in the future to encourage users to use public transport. Moreover, according to a study conducted by Chiu (2014), there are similarities in the findings of the study where the criteria of places is one of the most important factors where the environment, safety, and cleanliness of railway stations should be emphasised. In addition, the operation of railway stations also plays a role in attracting users where it involves time and quality of travel. The findings of this study have proven through the FM approach, the level of quality of the railway transportation system can be improved if these criteria can be

studied and improved over time. It is hoped that this study can provide ideas to the relevant parties to improve the level of accessibility of these railway stations to encourage users to use these facilities in order to reduce traffic congestion in our country.

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GOOD GOVERNANCE PRACTICES AND RECYCLING PROGRAMMES ADMINISTRATORS IN BATU PAHAT

Wei Guan Lim[1], Ta Wee Seow[1], Sulzakimin Mohammed[1], Indera Syahrul Mat Radzuan[1] and Muhamad Azahar Abas[2]
[1]Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor, Malaysia.
[2]Faculty of Earth Sciences, Universiti Malaysia Kelantan, Bachok, Kelantan, Malaysia.

Abstract
Landfilling is currently the preferred method of solid waste disposal in Malaysia. Malaysia is very much dependent on landfills as one of the cheaper and easier methods to manage the solid waste generation. However, many of the landfills in Malaysia are categorized as open dumping sites, and sanitary landfills are limited. Improper management of landfills, specifically the open dumping landfills, have resulted in environmental pollution. Following this, the life span of landfills is shorter and at critical levels due to the increase in solid waste generation. Moreover, Malaysia has been facing difficulties in identifying new sites for landfills, as communities protest new landfills. The Bukit Payong landfill project in Batu Pahat has been suspended and re-reviewed as a result of local community protestation. In the end, the Bukit Payong landfill project is still going on after the closure of the Simpang Renggam landfill. Additionally, the phenomena of illegal solid waste dumping have impacted the solid waste management efforts. Therefore, recycling is seen as one of the methods to reduce the solid waste that ends up in the landfills. The separation of solid waste at source enables to separate the recyclable solid wastes from the domestic wastes, thereby minimizing the volume of waste into the landfills. Nevertheless, the recycling rate is still low in Malaysia, as can be seen from the ineffectiveness of the solid waste separation at source method. Although many recycling programmes have been conducted to encourage the public to recycle, the recycling rate still undesirable. Hence, good governance practices need to be integrated into the formulation of recycling programmes. This research aims to determine the roles of solid waste administrators in recycling programmes of good governance practices in the effectiveness and efficiency, transparency, responsiveness, rule of law, consensus-oriented, responsibility and participation in the implementation of recycling programmes. The scope of study is in the areas of Batu Pahat. Three solid waste administrators have been selected from SW Corp, Local Government, and SWM. The method of research that has been adopted is interviewing the respondents with questionnaires. In general, waste and recycling administrators have faced many challenges, especially the lack of public participation, which has significantly impacted the sustainability of recycling programmes. There are many good governance practices that need further improvement for the administrators. This paper has recommended an enhancement of good governance practices integration in recycling programmes from the stages of planning, implementation, monitoring and improvement.

Keywords: *Recycling; governance practices; recycling programme administrator*.

INTRODUCTION

The recent increases in solid waste generation have become a challenge for Malaysia in its solid waste management processes. Most of the solid wastes generated have been disposed at landfills, which is the cheaper and easier method in solid waste management. Landfills have been used as solid waste disposal sites, and most of the landfills are categorized as open dumping sites. Improper management of landfills has caused environmental pollution (Seow, 2016). There are 230 landfills in Malaysia; out of which, only 10% of the landfills are still able to manage the high volume of wastes. Meanwhile, 90% of them are unable to manage the high waste content. Additionally, some landfills have been reopened temporarily to cope with solid waste management such as the *Sungai Kembong* landfill in Kajang and the *Ampar*

Tenang landfill in Sepang, as a result of difficulties in identifying new sites for landfills, and the increase of solid waste due to massive housing development (Zaini, 2017). Most of the landfills have reached the maximum or critical level. At the same time, new sites for new landfills have been difficult to identify as they are rejected by local communities, such as in the case of the Bukit Payong Landfill project. The Bukit Payong sanitary landfill project, which has cost approximately RM60 million, with a landfill size of 42.18 hectares, has been rejected by local communities. Subsequently, the Bukit Payong landfill project has been suspended for re-reviewing due to the complains from local communities. However, the Bukit Payong landfill project has been still going on after the closure of the Simpang Renggam landfill on 26 March 2019. Additionally, illegal dumping sites of solid waste have been identified as well.

Recycling provides a sustainable solution to the nation's solid waste management problems, especially with the increase in waste generation and the limited space for waste disposal (Manaf & Moh, 2014). However, most of the solid waste generated ends up in landfills, which are gradually facing a shorter lifespan. To tackle this, the government had launched the recycling programme in the year 1993 and had re-launched the programme in the year 2000. Nevertheless, the recycling rate was still found to be low, at 10.5% in the year 2012 (National Solid Waste Management Department, 2013), and 17.5% in the year 2016 (Alias et al., 2018). The government has taken many recycling campaign initiatives and has also introduced the Solid Waste and Public Cleansing Management Act 2007 (Act 672), and the Solid Waste and Public Cleansing Management Corporation Act 2007 (Act 673) to improve on the solid waste management problems (Jereme et al., 2015). The Department of National Solid Waste Management and Solid Waste and Public Cleansing Management Corporation were established to make executive policies relating to solid waste management respectively (Anwar et al., 2014). The government has enhanced its efforts in solid waste management and has set up the SW Corp under Act 673. Under Act 672, one of the objectives of setting up SW Corp was to integrate the practice of recycling into solid waste management. Hence, the method of waste separation at source has been implemented since 1 September 2015 under Act 672. The mandatory source separation provides the means for a higher recovery of recyclable materials and extension of the operating capacities of landfill sites (Intan et al., 2018). Yusof et al. (2019) conducted a study to review the current practice and challenges of community participation in waste segregation programmes in Malacca. The community participation in solid waste segregation and recycling programmes is still at a low level due to a lack of awareness, attitude, and exposure to the advantages of recycling in the long term. Instead, Zaini (2017) conducted a study to review the effectiveness of the implementation of Act 672 and the positive impact it has had in addressing the problem of solid waste and public cleansing in Batu Pahat. The study found that local communities have a high awareness of solid waste management and public cleansing. However, this awareness does not have an impact on the effectiveness of solid waste management and public cleansing, because of the constraints that limit the implementation of Act 672. Kamaruddin & Omar (2011) conducted a study in waste administrators regarding their main roles and responsibilities, efforts in promoting recycling or waste minimization and awareness in Selangor. The study found that there was low public participation in recycling, indifference of the public towards waste minimization efforts, and there were no clear guidelines on effective ways for administrators to conduct effective people-based approaches. The lack of enforcements for recycling is also perceived to contribute to the lack of participation from the public. Administrators perceived that recycling efforts should be the responsibility of each

individual, but the lack of commitment from the public in general to participate, misuse of recycling infrastructure, financial constraints and the absence of proper guidelines hamper many programmes' sustainability.

A pilot study was conducted by Seow and Abas (2015) and Seow et al. (2018) to investigate good governance practices in the implementation of the National Solid Waste Policy among SW Corp's staff. The study found that the awareness level of respondents towards good governance practices in policy implementation was moderate, based on their exposure and understanding of good governance practices. Seow & Abas (2015) in their study on good governance in solid waste management found that good governance is one of the crucial elements to attain effective policy implementation. A good governance concept defines that the decision is made in order to promote sustainable development, which includes environmental protection. The application of good governance is necessary to achieve sound waste management and a sustainable recycling industry (Seow et al., 2015). A poor governance is the main factor leading to the failure of the solid waste policy implementation (Seow et al., 2017). Ismail & Kaur (2015) conducted study of good governance in Malaysia's integrated solid waste management policy implementation. The implementation of Solid Waste Management and Public Cleansing Act (Act 672) in 2007 has been viewed as doubtful and feeble because landfills are still used as the conservative approach to solid waste management and the recycling rate is far behind the achieving target. Thus, a more integrated approach which focuses on good governance practices in solid waste management need to be undertaken. This paper's objective is to determine solid waste administrators' roles in the implementation of good governance practices in terms of effectiveness and efficiency, transparency, responsiveness, consensus-oriented, rule of law, responsibility, and participation in the recycling programmes in Batu Pahat.

In general, there are seven keys good governance practices that have been covered in this research paper. These are, effectiveness and efficiency, transparency, responsiveness, consensus-oriented, rule of law, responsibility, and participation. The description of these good governance practices is shown in Table 1.

Table 1. Good Governance Practices

Good Governance Practice	Description of Good Governance Practice
Effectiveness and efficiency	Process to produce results that meet needs while making the best use of resources.
Transparency	Built on the theory of free flow of information. Processes, institutions, and information are directly accessible to those concerned with them, and enough information is provided to understand and monitor them.
Responsive	Institutions and processes try to serve all stakeholders.
Consensus-oriented	It mediates differing interests to reach a broad consensus on what is in the best interest of a group and where possible, on policies and procedures.
Rule of law	Legal frameworks should be fair and enforced impartially.
Responsibility	Decision-makers in governance, the private sector, and civil society organizations are accountable to the public, as well as to institutional stakeholders.
Participation	All genders should have a voice in decision-making, either directly or through legitimate intermediate institutions that represent their intentions. Such broad participation is built on freedom of association and speech, as well as capacities to participate constructively.

(Source: Abas, 2019)

SOLID WASTE MANAGEMENT IN BATU PAHAT

SW Corp Batu Pahat is the government agency responsible for solid waste management. SWM is the concession company appointed to manage the waste in Batu Pahat. The local authority provides assistance to SW Corp in solid waste management. In general, daily solid waste generation in Batu Pahat is 170 tons. Batu Pahat has generated 62,302.44 tons, 83,258.05 tons, and 84,331.26 tons of waste in the years 2014, 2015, and 2016, respectively. Table 2 shows the yearly waste generation in Batu Pahat.

Table 2. Solid Waste Generation in Batu Pahat

Year	Total Waste in Tons
2014	62,302.44
2015	83,258.05
2016	84,331.26

(Source: SW Corp Batu Pahat)

The waste composition in Batu Pahat comprises of domestic waste, paper, plastic, steel, diapers, and others. Majority of the waste generated in Batu Pahat is domestic waste (51%), paper (9%), plastic (14%), steel (3%), diapers (12%), and others (10%). This composition of solid waste in Batu Pahat is summarized in Table 3.

Table 3. Solid Waste Composition in Batu Pahat

Type of Wastes	Percentage (%)
Domestic waste	51 %
Paper	9 %
Plastic	14 %
Steel	3 %
Diapers	12 %
Others	10 %

(Source: SWCorp Batu Pahat)

All the waste generated in MPBP (*Majlis Perbandaran Batu Pahat*) has been disposed in the Simpang Renggam landfill. Meanwhile, the solid waste generated in MDYP (*Majlis Daerah Yong Peng*) has been disposed in the TP Jalan Muar landfill. Currently, the Simpang Renggam landfill has been closed and the Bukit Payong landfill project is going on, even though the local communities have rejected the project. The Bukit Payong landfill costs approximately RM 60 million and has a land site of 42.18 hectares. It is a sanitary landfill with energy-to-energy technologies and its function is to manage the solid waste coming from Batu Pahat, Yong Peng, Muar and Simpang Renggam.

RESEARCH METHODOLOGY

This study aims to determine the roles of solid waste administrators in recycling programmes in terms of good governance practices. The scope of study is in Batu Pahat, Johor. The population of Batu Pahat is 401, 902 in year 2010. Solid waste management is under the administrative of SW Corp Batu Pahat. SWM is responsible in collection and disposal of solid waste in Batu Pahat. Batu Pahat Municipal Council and Yong Peng District Council are local authorities which administrates West and East Batu Pahat. Therefore, three solid waste administrators, SW Corp, local authority, and SWM have been selected for this

research paper. Three sets of questionnaires regarding the seven key good governance practices have been used for interviewing the respondents. Table 4 shows the general questionnaires of the seven key good governance practices.

Table 4. General Questions for the Administrator's Questionnaires

No.	Good Governance Practices	Questions
1	Effectiveness and efficiency	Implementation of recycling programmes of waste segregation at source, waste collection 2+1, and awareness seminar.
2	Transparency	Information regarding recycling programmes.
3	Responsive	Public satisfaction in terms of providing information, services, and complains of solid waste management and recycling.
4	Consensus-oriented	To maintaining public relations and mutual understanding for the best interest in recycling programmes.
5	Rule of law	Waste segregation at source.
6	Responsibility	Responsibility of administrators in recycling.
7	Participation	Public participation in recycling programmes.

RESULT AND DISCUSSION

This section has discussed the findings of the questionnaires of SW Corp, local authority, and SWM in Batu Pahat. These findings revolve around the areas of the implementation of the recycling programmes and the issues of the implementation of good governance practices in recycling programmes.

The Effectiveness and Efficiency of Recycling Programme Promotions in Batu Pahat

The administrators have conducted the promotion of waste segregation at source and waste collection 2+1 through a flyer and signboard aimed towards the local communities. Figure 1 shows the flyer of waste segregation at source.

a b

Figure 1. (a) Waste Segregation at Source Flyer; (b) Waste Collection 2+1 Signboard

The waste collection 2+1 signboard indicates the schedule of domestic waste and recycling waste of a household. The signboards have been distributed to each residential area under the SW Corp administration and SWM services. The waste collection 2+1 signboards have been distributed to a total of 57,378 premises in 262 residential areas. In addition, a

recycling seminar has also been conducted for the local community, school, private and public sector. Meanwhile, SWM has introduced the KITARecycle program. The KITARecycle program is aimed to encourage the public to collect recyclable waste and exchange it for points collection. The collected points, in turn, can be redeemed for cash rewards. The SW Corp, local authority, and SWM have also collaborated in the promotion of recycling programmes through social media such as Facebook, Instagram, and WhatsApp in Batu Pahat, for public participation.

The administrators view the problems of the recycling programme as a lack of local community participation in the recycling programmes, and a lack of interest in sharing recycling related information. Additionally, the recycling programme administrators have been facing financial constraints in conducting recycling programmes in Batu Pahat. There have also been issues of change of waste collection schedules as a result of waste collector vehicle break downs, or when the 2+1 signboards have been knocked down by vehicles. Another issue is the limited public understanding of the concept of waste segregation at source.

Therefore, the administrators have still been carrying out the implementation and promotion of recycling programmes in Batu Pahat. Further improvement and consistency are needed in the promotion of these recycling programmes to ensure the effectiveness and efficiency of the recycling promotions for the public in Batu Pahat.

Transparency in Providing Recycling Information

In general, the distribution of recycling information regarding waste segregation at source, importance of recycling, and waste collection schedule 2+1 through flyers and websites is understandable and accessible. The public is able to obtain further recycling information through the links of the websites of SW Corp, local authority, and SWM. Transparency issues that could arise in providing recycling information are when there is no update of the latest recycling information, and when public view the recycling information provided to be very general.

Responsiveness of Administrators Towards Public Satisfaction

SW Corp Batu Pahat has providing seminars on recycling upon requisition from the public. Meanwhile, SW Corp has also taken the initiative to conduct seminars on waste segregation at source for the local community or public sector. SW Corp receives public complaints of solid waste management through letters, telephone, and email. SWM implements the Corporate Social Responsibility principle in organizing recycling programmes for the public. Any feedback from the public would be discussed between the Regional Manager of North Johor and the Corporate Communications Unit before any announcement is made to the public. SWM manages responses to public complaints and handles any complaint within 24 hours. In addition, SWM also refers any public complaints to SW Corp for advice. The local authority also receives public complaints on solid waste management and channel these to SW Corp for further action. The financial constraints and lack of public participation in recycling programmes act as constraints in conducting the recycling programmes. SWM is currently facing a problem of understanding the public's needs so as to encourage public participation in recycling programmes.

Consensus-Oriented on The Best Interest of Public in Recycling Programmes

SW Corp practices two-way communication in the recycling programmes. All the recycling programmes conducted come with a question-and-answer session to enable the public to raise issues and questions related to recycling. SW Corp also provides communication channels of telephone or email for the public. SWM and local authority maintain the public relations via engagement and walkabout programmes through local community committees. The administrators are able to obtain the feedback from the public. WhatsApp groups have also been created to manage the issues in recycling. The public and SWM maintain good relations through the collaboration of SWM and the public in the implementation of ongoing recycling programmes. The local authority, SW Corp, and the local community committee collaborate in public relation enhancements through the friendly community programmes. There are issues of maintaining public mutual understanding due to public issues related to policy and regulation, which are time consuming to feedback to the public. The public has a misunderstanding that all the wastes are under the responsibility of SWM. As such, there is an issue of overlapping work scopes between SW Corp, local authority and SWM.

Enforcement of Waste Segregation at Source

Waste segregation at source has been implemented in premises under the administration of local authorities. There has also been an implementation of mandatory waste separation of recyclable waste and domestic waste at households. Waste separation at source flyers have been distributed from house to house in Batu Pahat. The mandatory waste separation programmes have been conducted since September 2015. The waste separation at source promotion has been channelled through television and radio. SW Corp has conducted waste separation investigations in 61,744 households between 1st September 2015 and 31st March 2016, and a total of 3,056 warning letters have been issued for not practicing waste separation. Under Act 672, a maximum penalty of RM1,000 can be imposed on anyone who does not practice waste separation. However, SW Corp still chooses to educate the public in waste separation instead of imposing penalties on them.

There have been issues in the enforcement of waste segregation at source. SW Corp revealed that the public complained that employees of SWM had mixed the segregated waste, no plastic bags were made available for waste segregation, and that a number of local communities had sold the recyclable items.

Responsibility of SWCorp, Local Authority and SWM in Recycling Programmes

The responsibility of SW Corp is to enhance the recycling practice in Batu Pahat and reduce the solid waste disposal at the landfill. SW Corp also works with the local community in obtaining the information of non-compliance of concession companies in recyclable waste collection. SW Corp Batu Pahat is responsible for implementing recycling policies under the ACT 672. SW Corp is also responsible for conducting recycling awareness programmes for the public, to encourage them to recycle.

The Local authority is responsible for assisting SW Corp in recycling programmes. Meanwhile, SWM is responsible for assisting SW Corp and the local authority in ensuring

that the public practice recycling in Batu Pahat. SWM conducts the waste collection and provides monthly waste data to SW Corp. SW Corp and SWM on occasions visit the areas that do not practice waste separation. The main constraints to the implementation of waste segregation at source are that the public segregate the waste wrongly and that the segregated wastes are non-recyclable waste.

Public Participation in Recycling Programmes

In general, enhancement of public participation in recycling is the priority of SW Corp Batu Pahat. SW Corp shall collaborate with the local authority and local community to conduct recycling programmes. Recycling promotions are ongoing programmes for the local community. SW Corp also distributes flyers of recycling information to the local community. SW Corp also plays a part in re-structuring the working partnership between the local authority and other agencies in recycling programmes. SW Corp also holds discussions with District Education Offices and KEMAS for the planning and implementation of recycling programmes in schools, and early childhood education programs in Batu Pahat.

Table 5. Issues of Good Governance Practices in Recycling Programmes under Recycling Administrators

No.	Good Governance Practice	Issues in Recycling Programmes
1	Effectiveness and efficiency of recycling programmes promotion	- Financial constraint to conduct recycling programmes. - Lack of public participation in recycling programmes. - Public understanding in waste segregation at source. - Changes of waste collection due to vehicle break down. - 2+1 signboard knocked down.
2	Transparency in providing recycling information	- Update of recycling information. - Recycling information too general.
3	Responsiveness towards public satisfaction	- Financial constraint to conduct recycling programmes. - Lack of public participation in recycling programmes. - Understanding the public needs.
4	Consensus-oriented in public best interest in recycling	- Maintaining public mutual understanding due to public issues related to the policy and regulation, which is time consuming to feedback. - The misunderstanding of the public that all the wastes are under the responsibility of SWM. - Overlapping work scope between SW Corp, local authority, and SWM.
5	Rule of law of waste segregation at source	- SWM mixing the segregated waste. - No plastic bags available for waste segregation. - Local communities sold the recyclable items
6	Responsibility of administrators in recycling	- The responsibility is to increase the exposure of the public to issues such as wrong segregation of waste and segregation of non-recyclable waste.
7	Participation of public in recycling programmes	- Lack of public interest in recycling. - Time and space constraint for recyclable waste collection.

SWM launched its own incentive-based programme for recycling across the three southern states in Malaysia. KITARecycle is a programme that encourages the public to recycle by rewarding them with Recycling Points for over 30 types of recyclable items which include paper, electrical items, scrap metal, cardboard, aluminum cans, plastics, and e-waste. The collected points can then be cashed out via online banking. However, the public were not interested in the KITARecycle programme, as the reward values for the Recycle Points were very low. Additionally, there were also space and time constraints for the public in the collection of recyclable items. SWM also provides recycling mobile counter and conduct survey toward the public for better understanding in recycling. Table 5 above shows the

overall issues of good governance practices in recycling under the recycling administrators in Batu Pahat.

CONCLUSIONS

In general, the recycling programme administrators are facing many challenges in terms of good governance practices. Among the challenges, public participation has significantly impacted the recycling programmes as there is a serious lack of public participation. Yusof et al. (2019) found that community participation in solid waste segregation and recycling segregation is still at a low level due to a lack of awareness, attitude, and exposure to the advantages of recycling in the long term. Hence, good governance practices shall provide the necessary exposure to the waste administrators, as a study of Seow and Abas (2015) states that the awareness level of SW Corp's staff towards good governance practices in policy implementation was moderate, based on their exposure and understanding of good governance practices. Additionally, good governance practices are one of the crucial elements needed to attain effective policy implementation. Besides, many of the good governance practices need improvement, especially the ones that involve public participation in recycling programmes.

Stakeholders in recycling programmes are advised to enhance their strength in good governance practices integration into the recycling programmes formulation from the stages of planning, implementation, monitoring, and improvement. Further study shall consider the integration of management and PDCA (Plan, Do, Check, Act cycle) concepts into the formulation of recycling programmes. These approaches to integration will enable the development of well-managed and systematic, sustainable recycling programmes for continuous improvement.

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DESIGN OF ELECTRIC BICYCLE USING THREE WAYS BATTERY CHARGING AS ECO-FRIENDLY TRANSPORTATION

Pamor Gunoto[1], Endang Susanti[1] and Seow Ta Wee[2]
[1]Electrical Engineering Department, Faculty of Engineering, Riau Kepulauan University, Batam, Kepulauan Riau, Indonesia.
[2]Faculty of Technology Management & Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor, Malaysia.

Abstract
The level of pollution caused by combustion engine every day is increasing in big cities as Batam city. Therefore, the use of electric vehicles as Eco-Friendly transportation is an urgent need. The biggest challenge for electric vehicles as main transportation is the short distance travelled due to the limited electric power battery and the longer time for battery charge time. It can be overcome by charging the battery at any time and wherever the electric vehicle. In this study, electric bicycle is using a battery with 3 (three) ways of charging, which are using a solar panel when stopping/parking, a DC generator when running and a 220 V PLN power while in the room/house. The driver power for electric bicycle uses a brushless DC motor and as a electric power storage uses lead acid battery. The results of testing and data analysis of electric bicycle, the distance of 3.9 km requires an average power of 54.7 watts. Based on the calculation of the analysis with average speed of 11.1 km/hour, the maximum distance that can be travelled by an electric bicycle is 49.2 km.

Keywords: *Electric bicycle; three ways battery charging; solar panel; eco-friendly transportation.*

INTRODUCTION

The solution to overcome pollution that is increasing is the use eco-friendly vehicles. Electric vehicle has component consisting of a power source as a charger, battery, controller and electric motor. One example of transportation being developed is a hybrid vehicle that uses human power and an electric motor. Inefficiency the use of electric vehicles as transportation needs because these electric vehicles are not only short distances but also slow speed. In addition, the battery charging time is less efficient, which is very long compared to oil-fuelled motor vehicles which are very fast in refuelling at gas stations. On the other hand, the use of human-powered vehicles is considered to cause fatigue, so these vehicles are only used for short-distance transportation, recreational activities and sports (Nainggolan et al., 2016).

The hybrid system, also known as the Power Assist System (PAS) has a number advantage, including less energy consumption and faster than human-powered vehicles that no pollution, no fossil fuels usage, less noisy, safer ride and low maintenance cost. A bicycle with a PAS is enough light that is can be used as usual using the pedals, but the power released by the rider is not as bigger than regular bicycle because it is assisted by an electric motor. This allows the rider to cover longer distances the same energy effort (Muh. Firman et al., 2016). Electric bicycles use batteries as energy source to drive an electric motor. Electric bicycles use batteries as an energy source to drive an electric motor. The strength of the battery in issuing electric power will greatly determine the use of an electric motor to run an electric bicycle (Didik, 2015).

Recharging the battery can using 220 PLN power source, solar panel and DC generator. Charging the battery using one has several disadvantages cause the distance travelled by electric bicycle is short due to the limited battery capacity. The use of the PLN as battery charger when the e-bike in the home or room due to the unavailability of the power source in the public area. Meanwhile, the usage of solar panels is highly dependent on the condition of sunlight intensity. The use of a DC generator as electrical energy because the pedal power generated is not only used to move the generator but also the bicycle wheel (Didik S, 2015).

The purpose of this research is to design and manufacture e-bike with a battery charging system combining three source electricity as a 220 V PLN power source, solar panels and a DC generator. The result of this research is a prototype of a three-wheeled electric bicycle that can travel longer distances and better speed because the battery is still charged with sufficient electricity to drive the electric motor. Charging the battery can be done anywhere and anytime while in the room/home using a 220 V PLN electricity source, using solar panels when outside the house/parking area or when the bicycle is walking on the highway during the day, while using a generator when the bicycle is running on the street in evening. So that this electric tricycle can be used as a means of transportation that is environmentally friendly and able to meet the needs of the community as an alternative means of transportation to reduce the level of air pollution due to exhaust emissions, reduce dependence on fuel oil and develop similar vehicles in the future.

LITERATURE REVIEW

Design of E-bike using Solar Panels as Battery Charger

Energy requirement of e-bike in various road conditions as study using e-bike with solar panel (Benhur N et al., 2016). They have designed an e-bike using solar panels as a battery charger which runs motor of the vehicle. In this study determine the energy requirements of an e-bike with various road conditions so that it can determine the specifications of the electric motor and the power of an effective solar panel. To find out the characteristics of e-bike, the battery charging time, speed testing and performance testing were carried out in road conditions that had an elevation of 15^{o}.

E-bike as Alternative and Environmentally Friendly Vehicle

Comparation the mileage and average speed of e-bike using and without solar panel on horizontal and uphill road conditions. It was found that the used solar panel is better at e-bike as an additional power source for battery chargers (M. Firman, 2016). Furthermore, the research to determine the mechanical characteristics of solar e-bike. Calculation of motor power and working efficiency of the motor by considering the chain and sprocket transmission system used on the solar-powered bicycle. The output power of the motor produced is influenced by the torque and angular speed by the motor (Didik S, 2015).

A zero-emission vehicle is powered by solar PV panels through storage batteries and the traction is obtained by an electric motor. The solar powered electrical vehicle is also considered, because of less noise, less pollution and reduce greenhouse gas emission (GHG) (M. Premkumar et al., 2018).

E-bike as Simplified Riding with Minimal Effort and More Economically

E-bike give a clean and more economical solution to the energy crisis. People use bikes and fuelled vehicles for even travelling short distances without making use of bicycles and non-fuelled vehicles. Most people riding a cycle to providing extra effort for cycling. So, to avoid this situation, electric assistance has been provided to cycle that will ease the user to ride with a motor. Even the hardship of climbing slopes and riding on rough terrains has been reduced (K. Sai Chandu et al., 2019).

MPPT Charge Controller on Solar Panel

The efficiency of power solar panel influenced by the intensity of sunlight and the solar panel temperature. The MPPT method, the solar panel voltage power can be optimized to charge the battery, so it does not depend on the weather and temperature (M. Harits et al., 2017).

E-bike with Self Recharging Mechanism

The calculation power output produced by the flywheel which is connected to a chain transmission system and gear ratio. It can be used as battery charger to the fullest (Vivek V Kumar et al., 2014). The manufacture the manufacture of electric bicycles with three ways of charging the battery, namely the main power source, DC generator and 15 Wp 12 V solar panels. The research uses battery settings and protection circuits using the ATMEGA 328 microcontroller. The design of this electric bicycle is used with flat road conditions (Beenu M et al., 2016).

The Power System of an Electric Vehicle

Design the power system of an electric vehicle that requirements due to driving distance and acceleration. The modelling and design of the power system to charge and run electric vehicle. The electric vehicle there is a problem of discharge to an extent limited range and more time for charging batteries. The free powered electric vehicle is a battery vehicle which run on free powering generator which mechanical energy and convert into useful electric work so that it charges batteries. (Pranav N et al., 2018).

Electric vehicle consists of PV panel, charger controller, battery, electronic speed controller and BLDC motor. The design is drawn from the solar panel should be used to charge a battery which runs the motor of the vehicle. As simple DC-DC converter acts as interface between the solar panel and the battery to obtain the required constant voltage and it will extract maximum power from solar PV panel (M. Premkumar et al., 2018).

RESEARCH METHODOLOGY

Research Design

This research method was carried out in several stages adapted to existing tool design process determination are: 1). The BLDC motor used, namely a 24-volt, 250-watt DC electric motor and 3300 rpm. 2). The BLDC controller according to the voltage and speed of the DC

motor. 3). The solar panel to be used is 24 V 50 Wp (watt peak) solar panel which is adjusted to the load of the DC motor used. 4). The controller (Solar Charge Controller) that will used for solar panel or electrical equipment. In this design 12/24 V and 30 A controller. 5). The DC Generator used is 24 V and 1 A. 6). The Lead Acid Battery (dry battery). The battery used 24 V and a capacity 36 Ah in series circuit.

This research method consists of the method of designing and manufacturing electric bicycles as well as testing tools. The design of this electric bicycle uses three sources of electricity as a battery charger, namely a 220 V PLN power source, solar panels and a DC generator. The test is carried out by measuring the average power for 7 days generated by a 24 V 50 Wp solar panel. The measurement will be made every hour from sunrise to sunset (09.00 – 17.00) per day.

Component Design

The design of e-bike is carried out through 2 stages of manufacture. The first stage is the manufacture of e-bike frame with a design using by 3 wheels consisting of 2 front wheels and 1 rear wheel. This design is intended to make the bicycle more stable and ergonomic in pedalling and riding it. Figure 1 shows the design of an e-bike will made.

Figure 1. Frame and Electrical Design

The second stage is assembling the electricity and control system on the electric bicycle. Figure 2 below is a design block diagram of an e-bike.

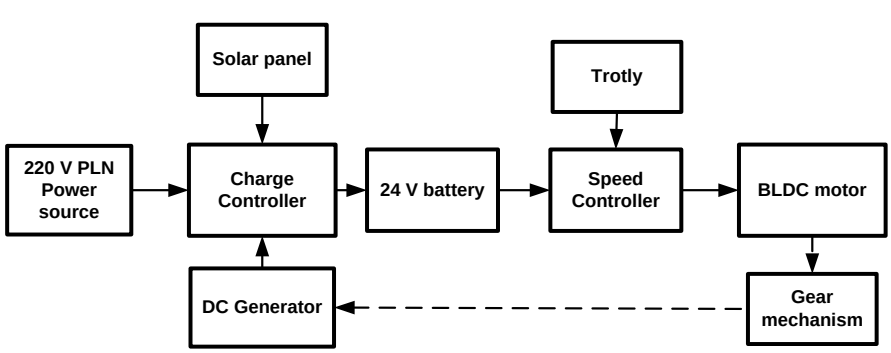

Figure 2. Diagram Block of E-bike Design

The design of this e-bike uses 3 sources of electricity as a means of charging the battery are: solar panel 24 V 50 Wp as producers of electrical energy from solar panel, a DC generator as electricity source when e-bike moving and a PLN electricity source at home.

The batteries as storage of electrical energy generated from three electricity source used. The storage controller to the battery is governed by a charge controller. The wiring for the battery is designed as shown in Figure 3 below:

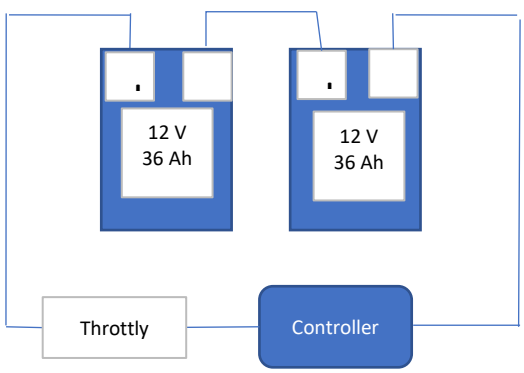

Figure 3. Series Battery Circuit

The charging battery if the voltage battery decreases through the controller (SCC) which control to disconnect current when the battery voltage fullest charge. This setting is to prevent the battery from being damaged due to overcharging or running out of current (deep charging). In this design the battery functions as a store of electrical energy that will be used to drive a DC motor. The battery charge condition can be monitored from the installed battery level display. To regulate the speed of the DC motor, it is controlled by a speed controller using the throttle which will regulate the amount of voltage applied to the DC motor.

Then the measurement on the DC generator to determine the magnitude of the voltage and current generated when pedalled using the pedal and the condition of the electric bicycle at a certain speed. This power measurement is carried out to find out how much power is needed and how long it takes to charge the battery when the bike is stopped and running. Furthermore, measurements are made to find out how far the electric bicycle can travel with the battery fully charged (full charge) with flat road condition and have elevation.

The design e-bike control system is to determine the component used are:

1. DC motor torque is:
   Pmotor = 250 W, V = 24 V, ω= 3300 rpm
   Tmotor = (60 x P)/(2 x π x n)
   T(motor) = (60 x 250)/(2 x 3.14 x 3300)
   = 0.724 Nm

2. DC motor load is:
   W = P x t (Wh)
   = 250 x 3600
   = 900,000 Joule
   = 250 W/hour

3. Capacity of solar panel
   Solar cell capacity = Total daily usage load/average bright sunlight
   = (250 W x 1 hr) / 4 hrs = 62 Wp

4. Capacity of battery
   Battery capacity = Total daily discharging load/voltage
   = (250 W x 1 hr) / 24 V = 10 Ah

5. Maximum speed of e-bike
   Vmax = ω.Rtire = 345.4 x 0.25 = 86.35 m/s = 310,86 km/jam

The determination of the distance travelled by an e-bike is largely determined by the weight of the load, the average speed of the electric bicycle and the capacity of the battery as a power source from the DC motor. The results of the design of an e-bike after the installation of components as shown in Figure 4 below:

Figure 4. Model Design of E-bike

Table 1. E-bike Specification

Component	Dimension	Specification
Frame	Length	204 cm
	Width	90 cm
	Height	152 cm
	Weight	112.5 Kg
	Diameter	50.8 cm
Motor	Voltage	24 V
	Power	250 W
Battery	Voltage	24 V
	Current	36 Ah
Solar Panel	Power (max)	50 Wp
	Voltage	24 V
	Current	2.81 A
Solar Charge Controller	Voltage	12/24 V
	Current	30 A
	Power	720 W

RESULTS AND DISCUSSION

Solar Panel Test Data

Data collection for solar panel test is carried out from 09.00 am – 05.00 pm. This data is taken to find out how much the open circuit voltage and current to the solar panel position of the sun. The table data for observing the solar panel output voltage is as follow:

Table 2. Solar Panel Voltage Output Data

No	Time	Voltage (V)	Current (A)	Power (W)
1	09.00 (am)	41.2	0.49	35%
2	09.30	42.1	0.55	35%
3	10.00	42.1	0.51	35%
4	10.30	41.6	0.51	35%
5	11.00	41.5	0.52	35%
6	11.30	40	0.41	35%
7	12.00	44.2	0.51	35%
8	12.30	40.6	0.5	35%
9	01.00 (pm)	41.5	0.52	35%
10	01.30	42.2	0.55	35%
11	02.00	41.5	0.55	35%
12	02.30	42.2	0.63	35%
13	03.00	41.5	0.6	35%
14	03.30	40.2	0.49	35%
15	04.00	38.2	0.44	35%
16	04.30	38.9	0.35	35%
17	05.00	37.0	0.34	35%
	Average	**41.0**	**0.5**	**20.5**

Based on Table 2, it can be seen that the highest voltage produced by the solar panel is 44.2 volts at 12.00 am, while the lowest voltage is 37.3 volts at 05.00 pm. The average output power of solar panel is 20.5 watt. The Figure 5 is to measure voltage and current of solar panel.

Figure 5. The Measurement of Voltage and Current from Solar Panel

DC Generator Test Data

The DC generator on e-bike have function as generator of electricity from the rotation of the rotor moved by pedal. The result measurement DC generator produces an average voltage of 1.8 volts at an average speed of 9.6 km/hour.

Table 3. DC Generator Test Data

No.	Speed (km/hr)	Voltage (V)
1	3.2	0.7
2	4.7	0.9
3	5.8	1.1
4	6.2	1.2
5	7.2	1.8
6	7.7	1.4
7	8.0	1.8
8	8.7	1.6
9	9.2	1.9
10	9.4	1.6
11	10.4	2.0
12	11.2	2.0
13	12.0	2.1
14	13.2	2.5
15	14.6	2.7
16	15.8	2.6
17	16.0	3.2
Average	**9.6**	**1.8**

The DC generator is coupled to a chain on the gear connected to the wheel axle, so the rotation of wheel will rotate the generator axle. The DC generator testing is obtained by comparing the speed of the electric bicycle and the voltage generated by the DC generator. The Table 3 above is the data from the DC generator test result.

Battery Charging Measurement Data

For charging the battery by a 50 Wp solar panel separately, with an average output power of 20.5 watt. The charging time the battery takes approximately 33.7 hours (1.4 days). From Table 4 below, it can be analysed that the addition of the average battery voltage is 4.3 volt for approximately around 62 minute (1 hour 2 minutes).

Table 4. Measurement Data of Battery Charging Time

No.	Initial Voltage (V)	Final Voltage (V)	Total Voltage (V)	Length of Time (Minute)
1	21.6	29.6	8.0	61
2	24.3	28.2	3.9	35
3	21.4	25.1	3.7	106
4	22.9	23.9	1.0	39
5	22.7	28.8	6.1	35
6	21.3	24.9	3.6	60
7	23.1	28.8	5.7	105
8	25.8	28.8	3.0	56
9	25.3	28.8	3.5	54
Average			**4.3**	**62**

Mileage Based on Battery Power Consumption Data

The maximum mileage of an e-bike that designed depends on the capacity of the battery that can be stored by the battery as long as it is used as DC motor drive. In the design of this e-bike, it uses a 36 Ah/24 V battery so that when fully charged it can store 864 Wh of power. By calculating the effectiveness of the battery is 80%, so the battery can store the power of 691.2 Wh. With a DC Motor load of 250 watt, in this design the battery can be used for 2.76 hours. The Table 5 show battery power usage test data on mileage. The data obtained experimentally by testing running e-bike on the road. From table 5can be obtained that the average battery power required is 54.7 watts for every 3.9 km distance, so the maximum distance that can be travelled with 691.2 Wh battery power is 49.2 km. However, the distance achieved will depend on road conditions and weather condition when the e-bike is used.

Table 5. Measurement Data of Battery Power Usage on Mileage

No.	Initial Power (watt)	Final Power (watt)	Total Power (watt)	Mileage (km)
1	354.4	299.9	54.6	2.1
2	373.0	272.2	100.8	5.8
3	306.2	303.7	2.5	1.0
4	301.1	269.6	31.5	4.0
5	362.9	313.7	49.1	1.5
6	351.5	267.1	84.4	4.0
7	362.9	304.9	58.0	7.0
8	317.7	272.2	41.6	2.0
9	362.9	274.7	88.2	8.0
9	307.4	298.6	8.8	2.0
9	362.9	281.0	81.9	5.0
	Average		**54.7**	**3.9**

The average speed that can be achieved is 11.1 km/hr. Based on this average speed, it can be calculated that the motor speed with e-bike load plus the rider becomes is 1.29 rpm.

CONCLUSION

The power required by a DC motor to drive an e-bike for 3.9 km is average of 54.7 watt. When charging the battery by solar panels, it takes for 1 hour to add an average voltage of 4.3 volt. The maximum mileage of the prototype an e-bike made is 49.2 km and the average speed is 11.1 km/hr. The power DC generator continuously supply electricity so that vehicle limited distance is improved but charging by DC generator is not optimally because average speed e-bike is 9.6 km/hour.

The e-bike is clearly seen that the electrical bicycle gives a clean and more economical solution to the energy crisis. People can simplify riding and less effort with electric assistance to ride the unit with the help of a motor.

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ENVIRONMENTAL SUSTAINABILITY AND THE EMERGENCE OF CORPORATE VOLUNTEERING: CASE STUDY IN JOHOR, MALAYSIA

Indera Syahrul Mat Radzuan[1,2], Muhamad Bakhtiar Azni[3] and Nor Hisham Md Saman[4]
[1]Department of Real Estate Management, Faculty of Technology Management & Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor, Malaysia.
[2]Malaysian Real Estate Institute (MyREI), Universiti Tun Hussein Onn Malaysia, Batu Pahat, Johor, Malaysia.
[3]Corporate Communication Department (3R Unit), SWM Environment Sdn. Bhd., No. 3, 3A & 5,5A, Jalan Kencana 1A/25, Taman Pura Kencana, Sri Gading, Batu Pahat, Johor, Malaysia.
[4]Department of Town and Regional Planning, Faculty of Architecture, Planning & Surveying, Universiti Teknologi MARA, Perak Branch, Seri Iskandar Campus, Seri Iskandar, Perak, Malaysia.

Abstract
Engagements between players such as government sector, corporate organization, institutional, NGOs and community are very crucial and have been identified as one of the most important solutions to overcome environmental issues. The success, and indeed the existence, of most environmental efforts depend on volunteers. This research focuses on how corporate volunteering emerged as a tool to promote and empower the environmental sustainability programmes in the state of Johor. This research evaluates the role of companies (Kumpulan Prasarana Rakyat Johor Sdn. Bhd., Johor Corporation, SWM Environment Sdn. Bhd., Medini Iskandar Malaysia and Ranhill SAJ Sdn. Bhd.) in conducting their corporate volunteering for sustainable environmental-based programme. It employed a mixed method approach by using interviews with executives and questionnaire survey with the workers from each organization. The analysis was performed to identify the different perceptions among respondents on each variable under study. This research tries to evaluate the implementation of volunteerism activities in respective organisations by looking at the motivation and strategies towards achieving sustainable development goals within their organisations.

Keywords: *Corporate volunteering; corporate social responsibility; sustainable development; environmental sustainability; volunteerism.*

INTRODUCTION

The pressing environmental issues in 21st century requires multi-sectoral and multi-stakeholder responses that recognise a wide range of concern and problems that exist in different nations. In a world that is undergoing rapid change, volunteerism is endless. It is a resource that is available in every community and is universal, dynamic, and creative, supporting by multifaceted solutions to the problem of maintaining environmental sustainability. In this study, the researcher aims to gain better understanding on the fundamental of volunteering concept and practices in selected corporate organisation to promote environmental awareness among their staffs and stakeholders. There are two specific objectives which assist the researchers in enhancing the findings. The first objective is to study the role of volunteers in facilitating environmental concern among the corporate organization while the second objective is to determine the effectiveness of the corporate volunteering programme in determining environmental awareness among stakeholders.

LITERATURE REVIEW

The Concept of Corporate Social Responsibility and Volunteerism

Governments have been primarily responsible for solving social issues for many centuries. However, in the late 18th century, social issues began to be addressed by concerned business people. Corporate social responsibility (CSR) refers to actions taken by businesses to address and combat social issues (Crowther & Aras, 2008). CSR dates back to the late 1800s, when firms began to re-evaluate their current production practises in response to the development of philanthropy and deteriorating labour conditions (Agudelo, Jóhannsdóttir & Davídsdóttir, 2019).

Business tycoons started making charitable donations, and some business owners (if somewhat reluctantly) cut back on hours worked and improved working conditions in factories, establishing the groundwork for ethical corporations. However, it wasn't until 1953 that American economist Howard Bowen released Social Responsibilities of the Businessman that the phrase "Corporate Social Responsibility" was first used (Schoff, 2021). In his work, Bowen realised the enormous power of businesses and the real social impact of their deeds. Therefore, he contended, businessmen have a duty to seek solutions that are advantageous for the public good.

In the 19th century, Malaysians were first exposed to the idea of volunteerism, which was motivated by religious and community revivals (Hussain, 1986). Throughout the twentieth century, volunteerism trend and demand continuing growth in many voluntary, public and private human service agencies to enrich service delivery (Cnaan & Goldberg-Glen, 1991). Bussell & Forbes (2002) observes volunteerism concept normally focus on charities work, business associations, supportive agencies, non-profit and non-governmental organisations. While, Mueller & Guild (2014) observed that businesses nowadays reflect volunteerism as part of their corporate social responsibility as it may attracts consumers and retains staff. By drawing on the same concept, Bussell & Forbes (2002) has been able to show that changes in social policies and economic development have led to increased dependency on volunteers.

Thus far, several studies have investigated why people volunteers and what benefits volunteers gain from taking part in those activities? Previous study on volunteerism has also examined and categorized the motivational objectives of individuals who participate in volunteering programmes. Yeung (2004) identifies that different motivations such as altruism, social contact, personal interest and emotional needs as some of the factors for people's involvement in volunteering activities. Drawing on an extensive range of sources, one of the major reasons for volunteering is giving something meaningful back to society. In Malaysia, the government continues to develop 'high impact, low cost' initiatives through volunteerism as part of its National Blue Ocean Strategy (NBOS) (Khalid Abu Bakar, 2016).

Factors Influencing Environmental Volunteering Practice

Numerous environmental literacy frameworks were developed beginning in the early 1990s based on the guiding principles, goals and objectives of volunteerism. As indicated by Chacon et al. (2011), he identified areas or aspects of volunteering includes issues such as social organization and movement, volunteer development, volunteer activities and services,

volunteerism knowledge, volunteer skills, volunteer management, volunteer organization management and volunteer leadership. There is a need to create a supportive environment for participation, engagement and volunteering for people, including what can be achieved and contribute through organizations. Corporate organizations who are engaged in volunteering possibly will develop positive social behaviours that can help reduce negative risk-taking. Apostolidis & Papaspyropoulos (2002) stated that voluntary action is related to provision of unpaid work, willingness and choice to participate, and the provision of work for a public purpose. Environmental volunteers appear to have various motivations. In an effort to create environmentally literate corporate organization society, they need to promote awareness by improving their participation in volunteering activities that related with environment sustainability practices. There are some factors that might contribute in promoting volunteerism awareness and such as roles, policy, environmental involvement and sustainable practices and environment awareness.

Roles

Roles referring to the determination of corporate sectors in promoting environment sustainable practices throughout the organizations. They need to explore the ways on how to boost the volunteerism among their employees. The impact of populations on ecosystems depends not only on the size of populations but also on how these populations' attitudes and behaviors towards maintaining better quality of environment. The corporations must learn to live with ecologically responsible consumption and urge people about environmental awareness and campaign. Corporate visions define the relationship of the company to its natural and human environments. The input system uses natural resources and energy, depleting them progressively, particularly the non-renewable ones (Shrivastava, 1995).

Policy

Policy can be a powerful tool towards more sustainable corporate management practices. Numerous environmental policy and frameworks were developed in the early 1990s based on the guiding principles, goals and objectives of UNESCO'S Tblisi Declaration to promote environmental educational initiatives in both formal and informal setting (NAAEE, 2021). Regulation plays a strategic role for the effective sustainable volunteering. It comprises of laws, standards, or mandatory management plans to restrict the negative behaviours that affect the sustainable practices among corporate sectors. Government policies and programme have mostly reduced environmental problems. However, because much economic activity occurs within corporations, they also need voluntary efforts from the employees and communities to address the ecological problems. Researcher need to get better understanding about the role of corporations in dealing with ecological problems. There is a need for corporate organizations to access information related to policy formulation, regulatory performance, environment impact studies and other information essential to sustainable development (Lim, 2018).

Environmental Involvement and Sustainable Practices

Environmental involvement describes participation in activities related to environmental matters. There are several ways for corporate organization to promote sustainable environment such as 3R (Reduce, Reuse, Recycle) practices, composting waste material,

using renewable energy resources to power living spaces and opting for public transport instead of private vehicles. Exposure to nature is often a benefit of environmental volunteering, which can involve activities like cleaning natural areas, testing stream quality, restoring habitats, and clearing invasive species. Previous research has discovered the positive effects of exposure to nature including improvements in cognitive functioning (Berman, Jonides, & Kaplan, 2008), enhanced psychological well-being (Kaplan, 2000), greater levels of physical activity (Ellaway, Macintyre, & Bonnefoy, 2005) and links to longevity (Takano, Nakamura, & Watanabe, 2002).

Environmental Awareness

Environmental awareness means being aware of the worth of protecting natural environment and of the reasons that cause environmental degradation to date. Moss (2016) stated that environmental awareness act as an educational tool to get better understanding on how to maintain better quality of environment. Knowledge is an essential requirement to instil good attitudes and behaviour. Highly educated individuals tend to be more concerned about ecological issues as they are more aware of potential damages (Lozano, 2006; Olli, Grendstad & Wollebaek, 2001). Environmental awareness is an environmental campaign which aims not only to educate people but also to encourage them with the right attitude which will consequently motivate them to apply green practices in order to sustain the environment. Several studies have shown that an in-depth knowledge of environmental issues and ways to resolve them would more likely result in actions for environmental protection (Kaiser & Fuhrer, 2003; Kollmuss & Agyeman, 2002; Mobley, Vagias & DeWard, 2010). However, awareness may not easily be translated into practices.

RESEARCH METHODOLOGY

This research utilizes mixed method to include both quantitative and qualitative method which involved interview and questionnaire survey for data collection. Pilot study has been carried out to test the efficacy of the research instruments before the actual in-depth research is conducted. The study uses simple random sampling method, which allows the researcher to generalize the findings of the sample to the targeted population. The simple random sampling method provide every individual with equal chances to be selected in the sample from the population (Acharya et al., 2013).

Johor was chosen as the case study based on the increased environmental concern and awareness between the industry player and stakeholders. Five companies were studied including Kumpulan Prasarana Rakyat Johor Sdn. Bhd (R1), Johor Corporation (R2), SWM Environment Sdn. Bhd. (R3), Medini Iskandar Malaysia (R4) and Ranhill SAJ Sdn. Bhd (R5). The companies were chosen due to their active implementation of sustainable corporate volunteering within their organisations. The interview was conducted online with respectively 5 officers from each organizations with at least executives level from Human Resource Department, Corporate Communication and Public Relation Department. While the questionnaire survey was distributed online from July to September 2021 among workers in each selected company under study. Application of the Statistical Package for the Social Sciences (SPSS) version 22.0 were used to track the frequency, percentage and mean to identify the different perceptions among respondents under study.

RESEARCH FINDING

Demographic Profile

Table 1 shows the respondents' demographic profile with gender breakdown was 36% male and 64% female. Out of the 100 respondents, the most representative group for this study include, 55% (20-29 years) followed by 27% (30-39 years), and 18% (above 40 years). For educational background, majority of the respondents obtained bachelor's degree (61%), with STPM/Diploma (21%), SPM (11%), Master (6%) and PhD (1%). In their respective organisation, only 15% hold the top management position, while 51% are executives, and the 34% are non-executives. Among them, 27 respondents have below 1 year of service, 42 respondents (1-2 years), 21 respondents (3-5 years) and 11 respondents (more than 5 years) working experience.

Table 1. Demographic Profile

		Frequency / Percentage (%)
Gender	Male	36 (%)
	Female	64 (%)
Age	20-29 years	55 (%)
	30-39 years	18 (%)
	40 years and above	18 (%)
Education Level	SPM	11 (%)
	STPM/Diploma	21 (%)
	Bachelor's degree	61 (%)
	Master	6 (%)
	PhD	1 (%)
Position in Organisation	Top management	15 (%)
	Executive	51 (%)
	Non-executive	34 (%)
Years of Service	1 year and below	27 (%)
	1-2 years	42 (%)
	3-5 years	21 (%)
	5 years and above	11 (%)

Environmental Sustainability Practice

Based on the survey, cultivating 3R practices (recycle, reuse, and reduce) recorded the highest rate of implementation with 97% responses (Figure 1) between the companies. It was followed by green practice with 91% responses, energy conservation (82%), environmental campaign (79%) and environmental talk (77%). Other than the programmes outlined, there are other green elements that have been implemented in their area/building such as the uses of LED lights, utilizing their premise area to set up green space as well as established the recycling corner. For recycling programme, some of the company participated in the study mentioned that, the involvement between employees and communities are acceptable with the establishment of recycling campaigns, forums and recycling-based competition were carried out. For instance, SWM Coca-Cola 3R Tours and WMAM Eco Youth Challenge are among the large-scale recycling programmes designed for educational institutions.

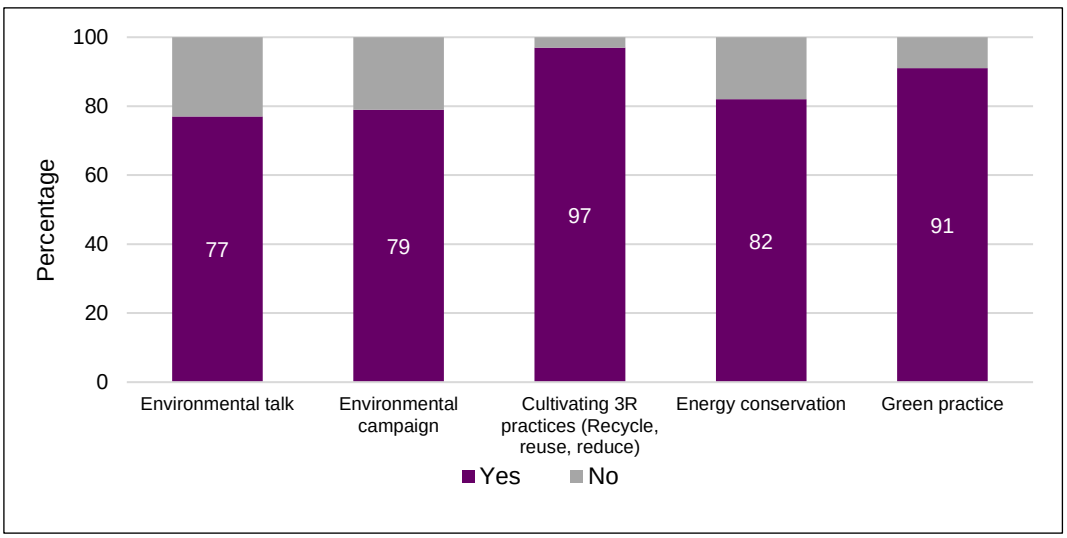

Figure 1. The Environmental Sustainability Programmes Held in Organisation

Other than that, environmental sustainability programme includes the plogging activity; trees-planting and environmental talk has been carried out. In this regard, either the internal or external activities are extremely important to conserve the environment as corporate organization has a great capability to get involved the both the employees and communities in sustainability programme.

Interest in Volunteering Activities

In this study, the interest of employees in volunteering activities were investigated. The respondents were asked on their interest in different types of volunteering activities as listed in the questionnaire form. Figure 2 visualizes the field of interest by the respondents in volunteering.

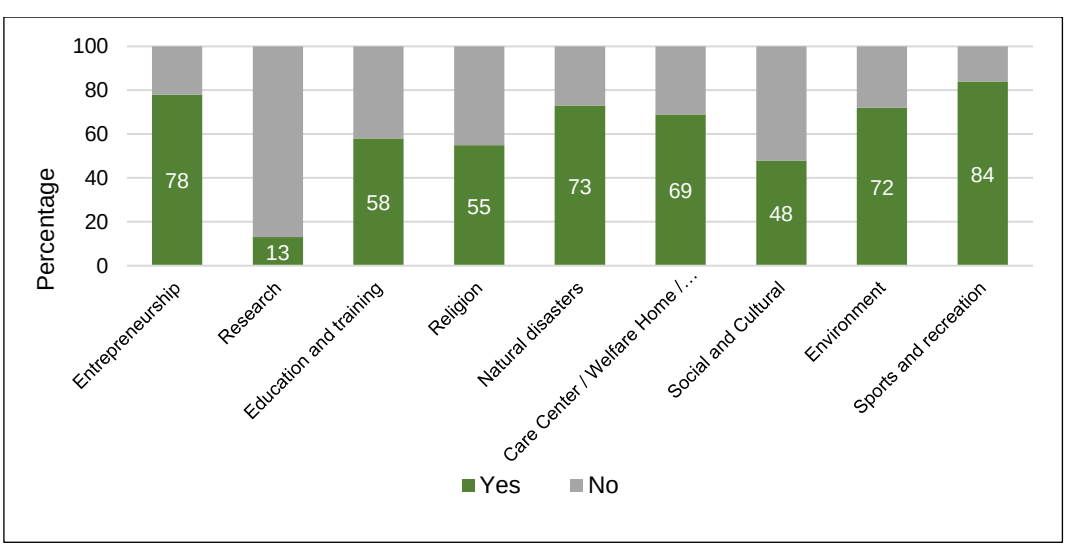

Figure 2. Respondents' Field of Interest in Volunteering Activities

For volunteering, sports and recreation obtained the highest rate with 84 responses. The volunteerism interests by the respondents are followed by entrepreneurship (78%), natural disaster (73%), environmental volunteering (72%) and care center/welfare home/shelter (69%). While approximately half of the respondents interested in activities including education and training (58%), religion (55%) and social and cultural volunteering (48%). Among the listed activities, research are the least interest by the respondents with 13% responses.

Strengthening Sustainability Programme

The respondents were asked on the most appropriate ways for their organisation to strengthen the corporate sustainability programme. Table 2 revealed that most respondents agreed a comprehensive budget are essential for the company to strengthen sustainability programme with the highest mean score values of 4.54. Meanwhile, improve social evaluation by providing recognition and appreciation recorded the second highest with mean score of 3.95. The participants also responded that continuous activities to increase awareness and engaging other bodies such as government, private organizations, communities, groups, individuals and volunteer bodies recorded the mean values of 3.83 and 3.46 respectively.

Table 2. Most Appropriate Ways for Organisation to Strengthen the Corporate Sustainability Programme

In your opinion, which are the appropriate ways from management to strengthen the corporate sustainability programme?	**SD**	**DA**	**N**	**A**	**SA**	**Mean Score**
Support through a comprehensive programme organization budget	0 (%)	1 (%)	15 (%)	13 (%)	71 (%)	4.54
Improve social evaluation for employees who are participating in volunteer programme by giving them recognition and appreciation	0 (%)	20 (%)	7 (%)	31 (%)	42 (%)	3.95
Carry out continuous activities to increase employee's awareness on environment	0 (%)	8 (%)	20 (%)	53 (%)	19 (%)	3.83
To increase the participation of other bodies such as government, private organizations, communities, groups, individuals and volunteer bodies	0 (%)	2 (%)	52 (%)	44(%)	2 (%)	3.46

Note: SD (Strongly disagree), DA (Disagree), N (Neutral), A (Agree) and SA (Strongly Agree). Mean score value approximately close to 5 indicates a degree of agreement.

Furthermore, from the interview inputs majority of the respondents commented that the involvement of the employees was extremely important and they were unanimous in the view of employees' participation. R2 suggested providing rewards for participants: *"In my opinion, the company can reward the employees or create awareness among the employees"*. R4 pointed out the similar opinions with respondents of questionnaire: "*For me, it is important to relate the sustainability programme with their interest to attract their attention and engagement in the programme"*. R3 and R5 also agreed with the way to foster it by providing extra credit for the involvement of employees in terms of KPI and other credit of appreciation. R5 concerned on the importance of controlling employees' workload: *"The employees' workload must be considered so they will be able to engage in the volunteering without stress and tensions"*.

As a summary, the conditions of the employees are the key point for the management team to foster the corporate volunteering. This can probably be related with the previous study where volunteers usually aim for returns during volunteering activities, which might increase the needs of sufficient and comprehensive programme' budget. Furthermore, a comprehensive programme budget is crucial to figure out the relevance and size of the event, which can measure the success, and performance of the programme. Therefore, financial support and employees' participation were concluded as the main direction for management to strengthen their corporate sustainability programme.

Perception and Views on Corporate Volunteering

Respondents were asked, "What are your perceptions and views on corporate sustainability volunteer activities?" Majority of them responded that to improve and promote corporate volunteering, having a good understanding on the challenges and advantages are essential while designing the volunteering programme. Table 3 shows the perceptions and views of respondents on corporate volunteering activities.

Table 3. Perceptions and Views on Corporate Volunteering

What are your perceptions and views on corporate sustainability volunteer activities?	SD	DA	N	A	SA	Mean Score
More responsible	0 (%)	0 (%)	10 (%)	79 (%)	11 (%)	4.01
Increase self-confidence	0 (%)	0 (%)	8 (%)	5 (%)	87 (%)	4.79
Enhance communication skills	0 (%)	0 (%)	2 (%)	17 (%)	81 (%)	4.79
Increase the company's concern for others	0 (%)	0 (%)	2 (%)	6 (%)	92 (%)	4.90
Opportunity for promotion	0 (%)	0 (%)	7 (%)	52 (%)	41 (%)	4.62
Expand social interactions and contacts	0 (%)	0 (%)	9 (%)	29 (%)	62 (%)	4.53
Increase self-motivation	0 (%)	0 (%)	8 (%)	37 (%)	55 (%)	4.47
Build company confidence	0 (%)	8 (%)	32 (%)	41 (%)	19 (%)	3.71
To increase knowledge	0 (%)	9 (%)	10 (%)	61 (%)	24 (%)	4.12
Volunteering as part of self- assessment (*KPI*)	0 (%)	(8 (%)	20 (%)	55 (%)	17 (%)	3.81
Provide support to the company	0 (%)	2 (%)	19 (%)	52 (%)	27 (%)	4.04
Continue to engage after working hours	51 (%)	28 (%)	15 (%)	6 (%)	0 (%)	1.76
Involve in company voluntary activities without thinking about reward	42 (%)	25 (%)	16 (%)	10 (%)	7 (%)	2.15
Burden	0 (%)	8 (%)	15 (%)	13 (%)	64 (%)	4.33
Too stereotype	0 (%)	6 (%)	5 (%)	19 (%)	70 (%)	4.53
Do not give profitable to company	16 (%)	34 (%)	37 (%)	8 (%)	5 (%)	2.52
Provide exposure to other companies	0 (%)	17 (%)	29 (%)	24 (%)	30 (%)	3.67

Note: SD (Strongly disagree), DA (Disagree), N (Neutral), A (Agree) and SA (Strongly Agree). Mean score value approximately close to 5 indicates a degree of agreement.

As indicated in Table 3, increase the company's concern for others was recorded the highest mean score values of 4.90. Besides, self-confidence and communication skills can be enhanced through the activities were agreed by majority of the respondents where both obtained a same value of mean score 4.79. Whilst, corporate sustainability volunteer activities provide the opportunity for promotion are recorded the mean score of 4.62. It was followed by both expand social interactions and too stereotype (4.53) respectively. Of this, increase self-motivation (4.47), to increase knowledge (4.12), provide support to the company (4.04),

more responsible (4.01), volunteering as part of self-assessment (KPI) (3.81), build company confidence (3.71) and provide exposure to other companies (3.67) score. However, other indicators with an average mean score below 3.00 point is recorded for statement such as continue to engage after working hours with the lowest mean score of 1.76, involve in company voluntary activities without thinking about reward (2.15) do not give profitable to company (2.52).

Attitude and Engagement in Environmental Sustainability Programme

Table 4 indicates the respondent's level of agreement pertaining to the statement of environmental sustainability programmes. Out of 100 respondents, 89 respondents had participated in an environmental sustainability programme, while the other 11 respondents did not. Next, there are 71 respondents who care about the sewage disposals around them while the other 29 respondents did not care about it. Out of 100 respondents, 60 respondents agree that it is necessary to do an environmental sustainability programme in their workplace while the rest of 40 respondents disagree with the statement.

Table 4. The Attitudes and Engagement of Respondents in Environmental Sustainability Programme

Statement	Yes	No
Have you ever participated in an environmental sustainability programme?	89 (%)	11 (%)
Do you care about the sewage disposals around you?	71 (%)	29 (%)
Is it necessary to do an environmental sustainability programme in your workplace?	60 (%)	40 (%)
Do you take note of the company's sustainability programme	75 (%)	25 (%)
As an employee, is it important to join corporate sustainability volunteers	82 (%)	18 (%)
Is it appropriate for your company to let staffs to join corporate sustainability volunteers	87 (%)	13 (%)
Do you think every corporate organization needs to do environmental sustainability activities?	91 (%)	9 (%)

Moreover, 75 respondents pay attention to their company's sustainability programme and the rest 25 respondents did not. As an employee, most of the respondents (82 respondents) agree on the importance to participate in corporate sustainability volunteering while (18 respondents) disagreed. Besides, 87 respondents agree that it is appropriate for the company to let staff join corporate sustainability volunteers while only 13 respondents disagree with this. Lastly, 91 respondents agreed that every corporate organization need to do environmental sustainability activities while only 9 disagreed.

Willingness to Participate in Volunteerism

Furthermore, respondents were accessed on their willingness to participate in volunteerism programme (Table 5). In order to measure their willingness, the five-point Likert's scale was used in this study. With the mean score value of 3.05, 2.72 and 2.62 respectively, the study found an average favourable willingness sentiment by the respondents. Indeed, it is important to clarify and emphasize the roles of each related aspects of willingness that can influenced and bring impacts towards volunteering activities.

Table 5. Views on Willingness to Participate in Volunteer Programme

Statement	SD	DA	N	A	SA	Mean Score
Do you enjoy working together with corporate sustainability programme volunteers?	0 (%)	31 (%)	43 (%)	16 (%)	10 (%)	3.05
Will you continuing involve in sustainability volunteer programme in your company?	15 (%)	18 (%)	52 (%)	10 (%)	5 (%)	2.72
Overall, are you satisfied with the sustainability volunteer programme in your company?	2 (%)	55 (%)	27 (%)	11 (%)	5 (%)	2.62

Note: SD (Strongly disagree), DA (Disagree), N (Neutral), A (Agree) and SA (Strongly Agree). Mean score value approximately close to 5 indicates a degree of agreement.

Employees' Motivation Factors to Participate in Volunteerism

The motivating factors to participate in corporate sustainability volunteer activities were tabulated in Table 6. Among the stated motivating factors, boost salary or position recorded the highest mean score values of 4.87. Besides, recognition (obtain certificate) and self-interest both obtained high mean score of 4.69 and 4.49 respectively. It was then followed by improve personal skills (3.76) and satisfaction of life (3.56). The factor regarding self-awareness recorded the lowest mean score values of 3.17.

Table 6. The Motivating Factors to Participate Incorporate Sustainability Volunteer Activities

What are the motivating factors to participate in corporate sustainability volunteer activities?	SD	DA	N	A	SA	Mean Score
Boost salary/ position	0 (%)	0 (%)	0 (%)	13 (%)	87 (%)	4.87
Recognition (obtain certificate)	0 (%)	0 (%)	8 (%)	15 (%)	77 (%)	4.69
Self-interest	0 (%)	0 (%)	12 (%)	27 (%)	61 (%)	4.49
Improve personal skills	0 (%)	0 (%)	49 (%)	26 (%)	25 (%)	3.76
Satisfaction of life	0 (%)	10 (%)	31 (%)	52 (%)	7 (%)	3.56
Self-awareness	0 (%)	14 (%)	65 (%)	11 (%)	10 (%)	3.17

Note: SD (Strongly disagree), DA (Disagree), N (Neutral), A (Agree) and SA (Strongly Agree). Mean score value approximately close to 5 indicates a degree of agreement.

From the interview session, R4 voiced out his opinion: *"Honestly, rewards will be the best motivating factor for me to engage in the volunteering after considering my own environmental awareness and interest"*. This will be one of the highlighted research findings to prove and emphasize the importance of getting rewards after paying great effort in it for an employee. Other important factors were employees' interest and environmental awareness level that suggested by R4 and R5. They will be engaged in the corporate sustainability volunteering when they are interested in environmental volunteering and having a high awareness level to save the environment from the crisis we met at present. These had been well proven in previous study and the response from respondents in this study. R1 even suggested that: *"It has to be done in a group of people to be the trend setter"* which utilizes the influencing power of trend setter. Lastly, R3 shared his opinion that the company itself will be the motivating factor for the employees to engage in the volunteering by having good management team, planning and relationship with them.

In summary, there are various motivating factors which can enhance the participation in corporate sustainability volunteer activities. The returns in the form of salary or position

boosting, recognition and personal skills improvement are among the motivating factors which agreed by most of the respondents. This can be well related with the research finding from the past studies that pointed out the returns from the volunteering activities are among the considerations for the volunteers to participate in it. Besides, company's management team also plays important roles in ensuring the well planning of activities based on the interest of employees and also providing appropriate recognition and rewards for them.

Key Role in Fostering Corporate Volunteerism

The respondents were asked, "Who do you think plays a key role in fostering volunteerism in the company?" Table 7 shows that Board of Directors recorded the highest mean score with 4.49, the Human Resource Department (4.37) and Head of (4.30). However, the mean score of 3.67 recorded for respondent who themself think that they play a key role in fostering corporate volunteering in their organisation, while colleagues recorded the lowest mean score values of 1.83.

Table 7. Key Person in Fostering Volunteerism in Company

Who do you think plays a key role in fostering volunteerism in the company?	SD	DA	N	A	SA	Mean Score
Board of Directors	0 (%)	0 (%)	7 (%)	37 (%)	56 (%)	4.49
Human Resource Department	0 (%)	0 (%)	12 (%)	39 (%)	49 (%)	4.37
Head of Department	0 (%)	0 (%)	20 (%)	30 (%)	50 (%)	4.30
Colleagues	37 (%)	41 (%)	21 (%)	1 (%)	0 (%)	1.83
Self	0 (%)	0 (%)	51 (%)	31 (%)	18 (%)	3.67

Note: SD (Strongly disagree), DA (Disagree), N (Neutral), A (Agree) and SA (Strongly Agree). Mean score value approximately close to 5 indicates a degree of agreement.

In addition, R2 suggested that: *"The leader is important. The employee will follow the leader. An employee group can be formed to lead employee action*s". As noted by R4: *"Management team is important in planning and everyone in the company is important in influencing each other to engage in volunteering"*. These responses ware reasonable because a management team plays the character as the leader in company and thus their leadership and influencing power will be highly relied by the employees while involving in company related activities. The same concept can be applied on another response of R1 which pointed out the influencers who can make volunteerism as a trend and create positivity ambience were playing the key role too in promoting the volunteerism in company.

Effective Sources to Convey Corporate Volunteerism Information

Table 8 shows the result of most effective source for conveying information about company volunteering activities chosen by the respondents. From the result, social media had been found to be the most effective source to convey information on company's volunteering activities which recorded the highest mean value of 4.86. It was then followed by other sources including newspaper (4.64), article (4.58), television (4.56) and organization (4.41). Co-workers recorded the lowest mean score value of 3.73 among the other sources of conveying the information.

Table 8. The Most Effective Source for Conveying Information About Company Volunteering Activities

	SD	DA	N	A	SA	Mean Score
Co-workers	0 (%)	10 (%)	28 (%)	41 (%)	21(%)	3.73
Organization	0 (%)	9 (%)	10 (%)	39 (%)	42 (%)	4.41
Television	0 (%)	0 (%)	15 (%)	14 (%)	71 (%)	4.56
Social media	0 (%)	0 (%)	13 (%)	8 (%)	89 (%)	4.86
Article	0 (%)	0 (%)	8 (%)	21 (%)	70 (%)	4.58
Newspaper	0 (%)	0 (%)	13 (%)	10 (%)	77 (%)	4.64

Note: Mean score value approximately close to 5 indicates a degree of agreement.

For the interview, social media again recorded the highest which can be referred by the R5 which opined: *"Social media will be the most effective source to convey information in this technology fast-growing generation"*. Since people nowadays already formed a heavy reliance on social media in daily life, social media such as WhatsApp, WeChat and Messenger became the main option for them to share news and information. There were also other options stated by R2 and R3 which used commonly in company such as email, company direct announcement and printed materials.

CONCLUSION

Volunteerism is a powerful mechanism that may attract greater participation from the societies for sustainable practices to address local environmental challenges and issues which may resulting in systemic changes. It is important to ensure that volunteerism is incorporated in all global, national and local plans for the implementation of sustainable development. It is important for volunteers to impose what they think is best for their company and environment. The environment programmes must be conducted with the consent and collaboration of all employees. The organisation volunteers play a significant role in building trust and mobilizing employees to develop awareness, changing attitude, achieving goals and overcome barriers for environmental protection and green practices. However, the difficulty lies not in the relativity of the concept but in its implementation.

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A STUDY ON CONSTRUCTION PROJECT SIZES IN SAFETY AND HEALTH: PERSPECTIVE OF CONTRACTOR AND WORKER

Haryati Shafii[1], Lim Xi Yi[1], Azlina Md Yassin[2], Mohd Hairy Ibrahim[3], Norliana Sarpin[1], Seow Ta Wee[1], Sulzakimin Mohamed[1] and Haidaliza Masram[2]

[1]Department of Construction Management, Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Batu Pahat, Johor, Malaysia.

[2]Department of Real Estate, Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Batu Pahat, Johor, Malaysia.

[3]Department of Geography and Environment, Sultan Idris Education University, Tanjong Malim, Perak, Malaysia.

Abstract

Construction industry was the main contributor for the development process of economic yet it was one of the most dangerous, dirty and difficult industries in the world which accounting for the high percentage of injury and fatal. Problem statement was different degree of safety and health practices in different sizes of construction project could influence the accident rate among worker at construction site. The objectives of the research were to identify safety and health practices in different sizes of construction project and to propose the method for improving safety and health in different sizes of construction project. This research was carried out in Johor especially in Batu Pahat and Kluang, targeted on small scale (G1-G3 contractor) and large scale (G6 – G7 contractor) of construction project for identifying safety and health practices among worker and contractor. Questionnaires and observation were conducted to develop both objectives in this research. Quantitative data was analysed by using Statistical Package Social Science (SPSS) Version 23. In the aspect of safety and health practices, contractor and worker involved in large construction project was higher than contractor and worker involved in small construction project. In management commitment aspect, 4.14 versus 3.56 (Contractor) and 4.31 versus 2.80 (Worker). In social aspect, 3.83 versus 3.03 (Contractor) and 3.88 versus 2.66 (Worker). In risk control aspect, 4.44 versus 3.88 (Contractor) and 4.62 versus 3.13 (Worker). Hence, both objectives were accomplished through mixed method. With the result of this research, it proved that still has an improvement space in the aspect of safety and health practices in small construction project in our country.

Keyword: *Size of construction project; safety and health; workers; contractor.*

INTRODUCTION

General, construction industry consists of various types of construction project such as residential project, building construction project, heavy construction project, industrial project and so on. However, the Malaysian Construction Industry (MCI) noted that construction industry was normally categorized into two areas, which were including general construction and special trade work. Residential construction, non-residential construction and civil engineering construction were the examples in general construction. Construction industry was one of the main contributors for the development process of economic in a country. According to Myers, D. (2013), there were variety of studies have emphasized that the significant contribution of the construction industry to the economic development in a country. In other words, construction could be categories as riskiest industry in the worldwide (Mneymneh, B. E et al., 2017). For example, value of construction completed by activity even completed by state in Malaysia indicated the trend was continually keep growing from year to year (Department of Statistics Malaysia, 2016).

However, construction industry in Malaysia, always labelling with 3D. 3D defined with Dangerous, Dirty and Difficult industries. The environment and workplace of construction industry was relatively potentially dangerous to the parties involved in a construction project especially worker. Even though certain improvements have been implemented over the last decades for improving safety and health in construction industry (Guo, B.H.W. & Yiu, T. W, 2015); (Hinze, J. & Hallowell, M. & Baud, K., 2013), yet the accident rate in construction sector was relatively higher than other industries over the world (Hinze, J. & Raboud, P., 1988).

For example, construction sites contributed 33 % or 13 cases of fatalities from the 39 deaths due to occupational accidents in Sarawak (Wu, H. & Fang, D., 2012). Safety at construction sites has become a major concern with 56 deaths recorded this year which made Johor rank top in contributing to the fatality accident at the sites (The Borneo Post Online, 2014). The Johor Occupational Safety and Health Department (DOSH) issued an order to stop all construction work at a site which near to Gelang Patah due to a fatal accident (Phaharoradzi, N., 2014). Other than that, an Indonesian construction worker was killed and four workers were injured due to a crane collapsed at a construction site in Petaling Jaya (Kili, K. A., 2017). Besides, accident at construction site, Hulu Selangor which lead to one dead and four injured was reported through The Star Online (Kumar, M., (2018).

In short, there was the reason why safety and health issues were necessary to pay close attention from year by year. Even though there were variety of previous research and improvement have been carried out yet the rate of accident in construction industry was still relatively frequently. Thus, a survey has been carried out in order to study the relevant topic of previous research from the year of 2002 to 2017. It could summarize that the awareness of safety and health, cause of accident at construction site and method to minimize accident at construction site were popular in the topic of safety and health.

Hence, this paper was to identify in detail on the relationship between construction project sizes with its practices in safety and health among worker and contractor, which might indirectly improve these issues in construction industry. The research objective for this paper is to identify safety and health practices in different sizes of construction project.

Background of Research

In construction industry, construction project could be classified as government project or private project. Government project could be categorized as a project awarded by government agency such as federal government, state government and statutory bodies, which were incorporated under the Act of Parliament. Conversely, private project refers to a project awarded by company, cooperation and organization, which registered with the Companies Commission of Malaysia (SSM), Registry of Societies Malaysia (RoS) and Malaysia Cooperative Societies Commission (SKM). According to the statistic done by Construction Industry Development Board (CIDB), the proportion of project between the government and private sector stand at 28% against 72% in 2016. This was further supported by second quarter construction project report of Construction Industry Development Board (CIDB) updated by June 2017 which stated that a total of 488 projects (22.88%) was government project yet 1645 projects (77.12%) was private project (Construction Industry Development Board (CIDB), 2017).

Apart from this, sizes of construction project were one of the main characteristics, which might influence safety and health practices in construction industry. There were including small scale and large scale of construction project. In general, sizes of construction project could determine by several factors such as total financial resources available, number of team member involved, complexity of services, timeframe required even the number and size of deliverable to be produced. The criteria for determining project sizes includes cost, risk, impact, strategic priority and complexity (Australian Catholic University, 2015). Besides, there were variety of factors could be taken into account for determining sizes of project such as degree of risk, technology requirement, number of key stakeholders, total cost and so on (Department of Premier and Cabinet, A., 2017)**.** Table 1 shows the criteria to determine construction project sizes.

Table 1. Criteria to Determine Construction Project Sizes

CRITERIA	SMALL	LARGE
Size of project team	1 - 2	> 5
Elapsed time	< 6 months	> 12 months
Timeframe	Schedule is flexible	Schedule is no flexible, deadline is fixed and cannot be changed
Complexity	Easily understand problem and solution is readily achievable	Both problem and solution difficult to understand and achieve
Total cost	< $25K	> $250K
Level of change	Impact a single business unit	Impact on whole organization

Source: Goetsch, D. L. (2010)

Other than that, tender capacity of contractor might indirectly affect safety and health practices for every construction project. For example, contractor could be categorized into G1 until G7 grade. Each grade would represent its own tender capacity for a construction project. Moreover, construction project requires certain input in order to provide output like goods or services. Client, consultant, labour and resources were the primary input that usually required for achieving the desired outcome. Labour or worker was one of the main inputs for the productivity of every construction project. Among the construction personnel, worker formed the largest share of personnel at 484,087 workers in 2015 and 546,788 workers in 2016 (Construction Industry Development Board (CIDB) (2017). It was a rapid growth in the total amount of worker in construction, which grew by 12.95% with the amount of 62,701 workers.

To sum up, worker who was responsible for conducting work at construction site was highly exposure to the dangerous of accident either in small scale or in large scale of construction project. Meanwhile, contractor who was be in charge of the progress and performance of the project plays a vital role in the aspect of safety and health practices. Hence, this research provides an opportunity for us to understand in detail on the relationship between construction project sizes and its practices in safety and health. In other words, an overview about construction accident could be presented and then certain improvement could be made in order to enhance safety and health practices among contractor and worker in the future.

Problem Statement and Objective

Problem statement was different degree of safety and health practices in different sizes of construction project could directly or indirectly influence worker's job performance and it was potentially increasing the rate of accident at construction site. According (Aswad, K.,

2010) and (Farham, W. M., 2014) , sizes of construction project could influence the practices in safety and health and its impact on the rate of accident among worker at construction site. Besides, (Leeth, J. D., 2012), stated that large scale of construction project was more concern about safety and health practices as compared with small scale of construction project. The chance of being disabled by illness or injury among worker in construction industry was much greater than another sector. Despite certain improvement of construction safety and health in comply with the Occupational Safety and Health Act have been implemented yet a series of construction work-related injury was still being reported (Kim, H. et al., 2016). This was further supported by various studies and report, the rate of work-related injury in construction sector was relatively higher than other area Chi, S. & Han, S. (2013); (Manu, P. et al., 2013; Argiles-Bosch, J.M. et al., 2014).

In Malaysia, the establishment of Occupational Safety and Health Act in the year of 1994 was reducing the rate of accident. However, safety and health still became a popular issue due to a higher demand in the sector of construction in Malaysia. Construction worker who works within the construction industry face a greater risk of fatality than worker in other industries. News and reports regarding to the topic of safety and health in construction industry was quite familiarly. The Department of Occupational Safety and Health (DOSH) stated that majority of worker in construction sector was non-permanent disability with the amount of 110 persons (62.15%), 63 persons were death with the percentages of 35.59% and minority of worker was permanent disability with the amount of 4 persons or 2.26% (Perlman, A. et al., 2014).

Apart from this, the significant of safety and health practice among worker in small scale of construction project might be neglected as compared to large scale of construction project. Small construction firm might lack of knowledge regarding risk and safety regulation as well as lack of formal system for safety and health management in any small scale of construction project (MacEachen, E., 2010). Lack of training in small scale of construction project due to financial constraint might contributed to the vulnerability of safety and health among worker (Cunningham, T. R. et al., 2018). Besides, the organizational factor such as project sizes could contribute to the greater vulnerability to workplace illness or injury among worker (Thomas, R. C. et al., 2018).

In short, this paper was necessary to be carried out for finding out the key factor that might influence safety and health practices in different sizes of construction project and then attempt to enhance and provide a safe workplace environment to the worker and contractor. The objectives are this research is to identify safety and health practices in different sizes of construction project and to propose the method for improving safety and health in different sizes of construction project. Based on this objective, this paper also presents with a methodology to achieve an objective and problem statement.

This research was carried out in Johor focusing on Batu Pahat and Kluang as well as only focus on the safety and health issues in construction industry. Other than that, this research was targeted on small scale (G1-G3 contractor) and large scale (G6-G7 contractor) of construction project for identifying safety and health practices. Worker and contractor were the respondent in this research. Besides, there were only few constructions site to be selected randomly in Johor. Thus, there was certain limitation and restriction to complete this research and the result might could not represent the majority of the construction company in Malaysia.

RESEARCH METHODOLOGY

Methodology was one kind of systematic technique generally used to gather or analysis data from variety of sources in order to achieve certain goal. In general, there were two different types of method could be implemented for collecting relevant data and information such as primary data and secondary data. Secondary data also known as second hand of data that collected from others at the earlier which could be defined as past source. Secondary data was a data collected by another researcher (Marican, S., 2005). For example, information gathered from book, journal, article, newspaper, report, government publication, thesis, statistics and data from relevant department, agency or company and others. However, primary data also known as first hand of data that gathered from the researcher, which could define as real time source. According to Rampal, K. G. & Nizam, J. M. (2006), primary data was a raw data or first source. Primary data could collect through qualitative and quantitative method such as interview, questionnaire, survey, observation and so on.

Questionnaires was collected from worker and contractor in different sizes of construction project. The selection of worker was basically based on the communication ability of worker. Either they were local worker or foreign worker must could be communicated in English, Malay or Mandarin. Meanwhile, observation was carried out at construction site as a method to observe and identify practices in safety and health in different sizes of construction project.

RESULT AND DISCUSSION

Profile of Respondent

Table 2. Questionnaires Response Rate for Contractor and Worker in Both Large and Small Construction Project

Large Construction Project		Small Construction Project	
Contractor	**Worker**	**Contractor**	**Worker**
BCB Construction Sdn. Bhd. (Site at Batu Pahat)	23 workers ($\frac{23}{44}$ x 100 = 52.27%)	Kian Chye Building Contractor (Site at Yong Peng)	12 workers ($\frac{12}{14}$ x 100 = 85.71%)
Wellcon Construction & Trading (Site at Batu Pahat)	31 workers ($\frac{31}{73}$ x 100 = 42.47%)	NCH Renovation Construction (Site at Yong Peng)	17 workers ($\frac{17}{24}$ x 100 = 70.83%)
Rosha Dynamic Sdn. Bhd. (Site at Parit Raja)	17 workers ($\frac{17}{28}$ x 100 = 60.71%)	BCB Construction Sdn. Bhd. (Site at Yong Peng)	8 workers ($\frac{8}{14}$ x 100 = 57.14%)
Psycon Sdn. Bhd. (Site at Sri Gading)	39 workers ($\frac{39}{70}$ x 100 = 55.71%)	Dekad Teknologi Sdn. Bhd. (Site at Parit Yanni)	11 workers ($\frac{11}{14}$ x 100 = 78.57%)
BCB Construction Sdn. Bhd. (Site at Tongkak Pechah)	36 workers ($\frac{36}{76}$ x 100 = 47.37%)	Mal Wah Selatan Sdn. Bhd. (Site at Kluang)	10 workers ($\frac{10}{14}$ x 100 =71.43%)
5 contractors	146 (51.71%)	5 contractors	58 workers (72.74%)

Response rate of questionnaires for both contractor and worker either in large or small construction project as shown in Table 2. Questionnaires response rate for contractor in both large and small construction project was 100% with 10 contractors. Yet, 146 questionnaires from large construction project were returned with an average response rate of 51.71% while 58 questionnaires from small construction project were returned with an average response rate of 72.74%. A comparison was carried out throughout this research, thus there were only

5 contractors as well as only 58 workers was taken randomly in both large and small construction project.

Reliability Test for Both Pilot Study and Actual Research

Reliability test was carrying out for estimating the internal consistency for both pilot test and actual research by using Cronbach's alpha. The purpose of pilot test was identifying the reliability and feasibility of the study. Pilot test was carrying out on 20 construction personnel randomly for both contractor and worker who located at Johor. Table 3 tabulated the reliability result of pilot test for contractor. Yet, Table 4 tabulated the reliability result of pilot test for worker. The value of Cronbach's alpha for 10 contractors were 0.981 yet 0.975 for 10 workers which as shown in Table 4 and Table 5. Based on the rule of thumb of Cronbach's alpha, the reliability result of pilot test for both contractor and worker were excellent due to $\alpha \geq 0.9$, which could classified as reliable.

Table 3. Reliability Result of Pilot Test for Contractor

Cronbach's Alpha	Number Of Respondents	Number Of Items
0.981	10	42

Table 4. Reliability Result of Pilot Test for Worker

Cronbach's Alpha	Number Of Respondents	Number Of Items
0.975	10	42

Besides, the reliability result of actual research for both contractor and worker as shown in Table 5 and Table 6. Table 5 shows 0.953 was the value of Cronbach's alpha for contractor which 42 questions were developed and answered by 10 contractors randomly. Meanwhile, the value of Cronbach's alpha for worker was 0.993 as in Table 6, which the number of respondents were 116 as well as 42 questions were developed. Based on the rule of thumb of Cronbach's alpha, the reliability result of actual research for both contractor and worker could concluded as excellent. Hence, this research indicated that the measurement items were internal consistency and reliable.

Table 5. Reliability Result of Actual Research for Contractor

Cronbach's Alpha	Number Of Respondents	Number Of Items
0.953	10	42

Table 6. Reliability Result of Actual Research for Worker

Cronbach's Alpha	Number Of Respondents	Number Of Items
0.993	116	42

Analysis: Background of Respondents

All data collected have been analysed and explained by using frequency distribution and percentage as well as presented in the form of diagram.

Contractor Grade

Based on Figure 1, 10 contractors were dividing into four group of contractor grade such as Grade 2, Grade 3, Grade 6 and Grade 7. There were same number of contractors for Grade

3 and Grade 7 with a frequency of 4 people (40%). However, there was only 1 contractor for both Grade 2 and Grade 6 with a percentage of 10%. It concluded that the number of Grade 7 contractor and Grade 3 contractor were three more people than the number of Grade 6 contractor and Grade 2 contractor.

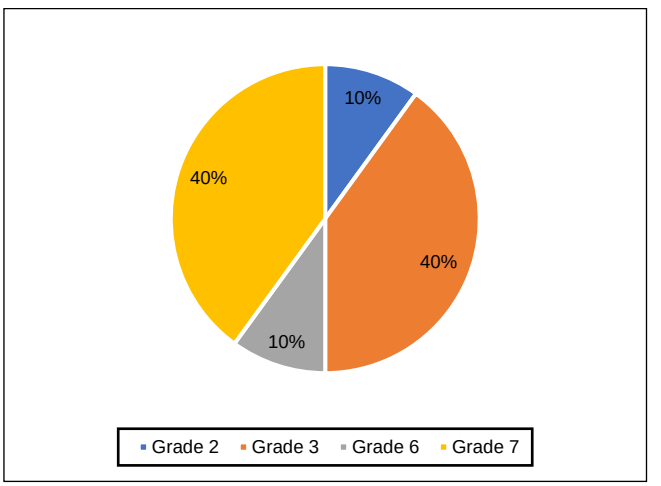

Figure 1. Percentage of Contractor Grade

Project Category

From Figure 2, it dedicated that project be in charge by 10 contractors could classified into two category such as government project and private project. Private project with a higher quantity of respondent with 8 contractors (80%). Yet, government project only has 20% with a frequency of 2 contractors. Hence, majority of the contractors were handling private project.

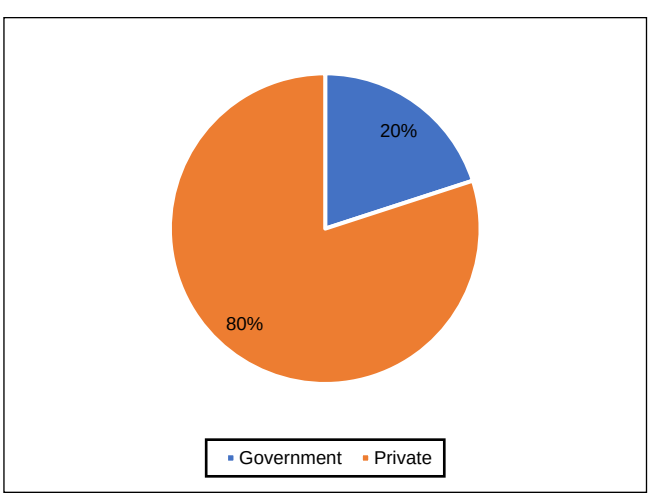

Figure 2. Percentage of Project Category

Respondent Experience in the Construction Industry

There were four range of respondent experience to be summarized in Figure 3. Majority of contractor was involved with 0-5 years and more than 15 years of experience in the

construction industry with a percentage of 30%. However, minority of contractor was involved in both 5-10 years and 10-15 years of experience in construction industry (20%). In short, the quantity of contractor for both 5-10 years and 10-15 years were slightly lower than the quantity of contractor for both 0-5 years and more than 15 years.

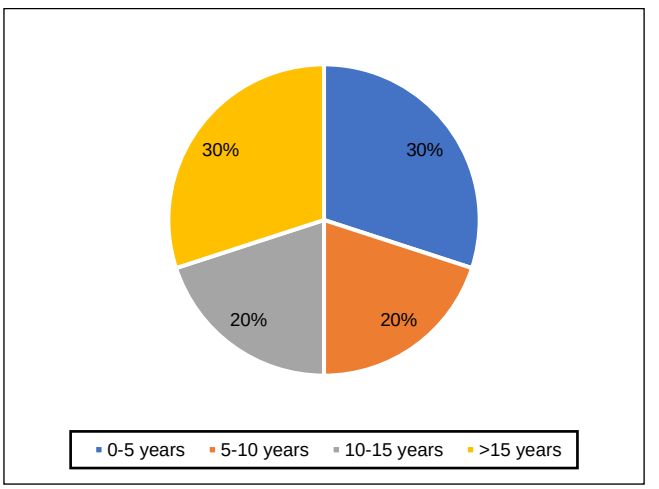

Figure 3. Percentage of Respondent Experience in The Construction Industry

Ethnic

Figure 4 shows the data of contactor's ethnic who involved in this research. It could conclude that Chinese contractor with a percentage of 70% (7 contractors) were the majority respondents as compared to Malay contractor with a percentage of 30% (3 contractors).

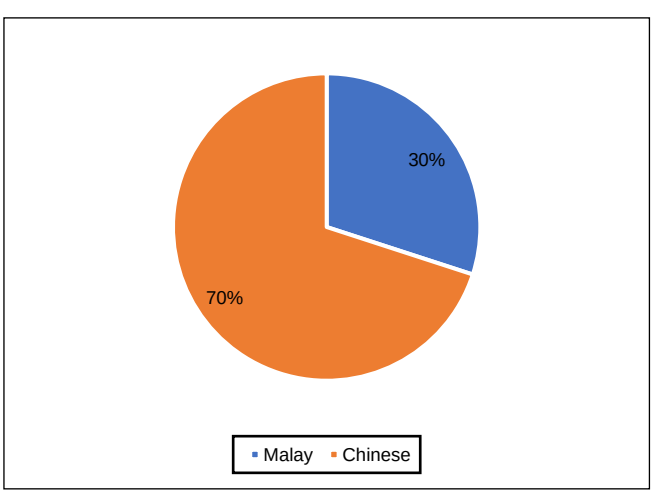

Figure 4.: Percentage of Ethnic

Education Level

The education level of 10 contractors as shown in Figure 5, which classify into secondary school, technical certificate, diploma and bachelor's degree. The majority of the contractor

have secondary school level, which includes 4 contractors (40%). Other than that, there were only 2 contractors (20%) for each technical certificate, diploma and bachelor's degree level.

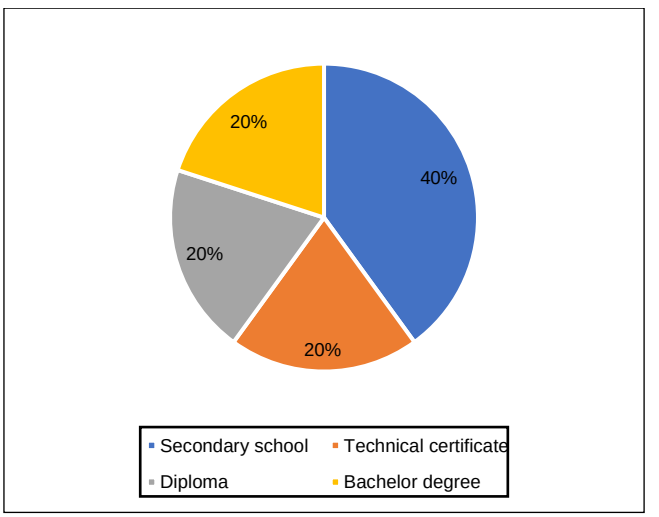

Figure 5. Percentage of Education Level

Analysis: Worker's Safety and Health Status

This section analyses and explains on the worker's safety and health status from the perspective of contractor. It was consisting of accident happened during construction project and kind of accident has been experienced or reported. Frequency distribution and percentage have been used in the table for the presentation of data.

Accident Happened during Construction Project

Table 7 tabulated the information of accident happened during construction project. No accident happened during construction project were contributed by 8 contractors (80%) yet there were 2 contractors have been response to accident happened during construction project.

Table 7. Accident Happened during Construction Project

Accident Happened	Frequency	Percentage (%)
Yes	2	20
No	8	80
TOTAL	**10**	**100**

Kind of Accident has been Experienced / Reported

Table 8 shows the kind of accident have been experienced or reported during construction project. There were two kinds of accident have been indicated by 10 contractors such as not serious and no medical leave or minor accident, medical leave not exceeding 4 days and less than 30 days. It shows that the highest percentage with a total of 90% (9 contractors) were involved in the accident of not serious and no medical leave. In contrast, there was only 1 contractor involved in the minor accident, medical leave not exceeding 4 days and less than 30 days (10%).

Table 8. Kind of Accident has been Experienced / Reported

Kind of Accident	Frequency	Percentage (%)
Not serious and no medical leave	9	90
Minor accident, medical leave not exceeding 4 days and less than 30 days	1	10
TOTAL	**10**	**100**

Worker Involved in The Construction Project

Table 9 indicated the number of workers involved in both large construction project and small construction project. All data was collecting around Johor area. It shows that a total of 345 workers have been involved in large construction project as compared to small construction project with 78 workers.

Table 9. Worker Involved in The Construction Project

Large Construction Project (Number Of Worker)	93 (Site at Tongkak Pechah)
	87 (Site at Batu Pahat)
	30 (Site at Parit Raja)
	50 (Site at Batu Pahat)
	85 (Site at Sri Gading)
TOTAL	**345**
Small Construction Project (Number Of Worker)	23 (Site at Yong Peng)
	15 (Site at Parit Yanni)
	13 (Site at Kluang)
	12 (Site at Yong Peng)
	15 (Site at Yong Peng)
TOTAL	**78**

Data Analysis of Worker

Analysis: Background of Respondents

This section analyses and explains on background of respondent such as worker category, experience in the construction industry, ethnic and Green Card holder. All data collected have been analysed and presented based on frequency distribution and percentage.

Worker Category

In construction industry, worker divided into three category such as skilled worker, semi-skilled worker and unskilled worker as shown in Figure 6. From the overall of 116 workers, there were 56 workers were skilled worker (48.28%) and followed by 42 of semi-skilled worker (36.21%). Lastly, 15.52% with a frequency of 18 unskilled worker were responding to this research. In short, skilled worker plays an important role in this research due to its highest percentage.

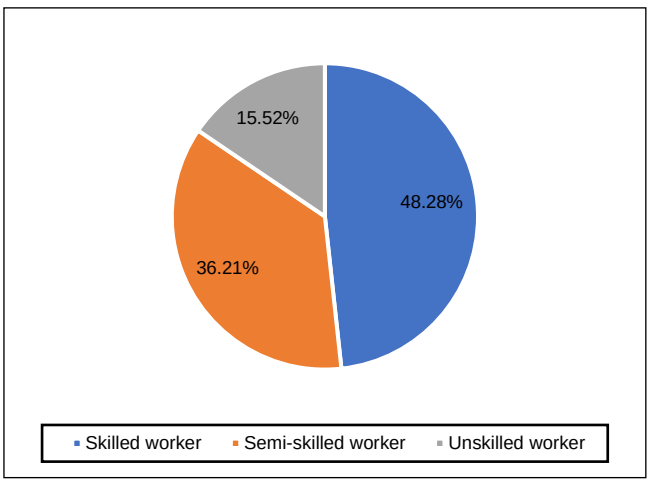

Figure 6. Percentage of Worker Category

Respondent Experience in The Construction Industry

The composition of the percentage was shows in the form of pie chart as in Figure 7. It shows that the lowest percentage with a total of 7.76% (9 workers) was in the range of 10-15 years. Besides, 12 workers with a percentage of 10.34% have more than 15 years of experience in construction industry. The second higher of worker's experience in the construction industry was 5-10 years with a percentage of 20.69% (24 workers). Lastly, 71 workers (61.21%) have the work experience in the range of 0-5 years in the construction industry.

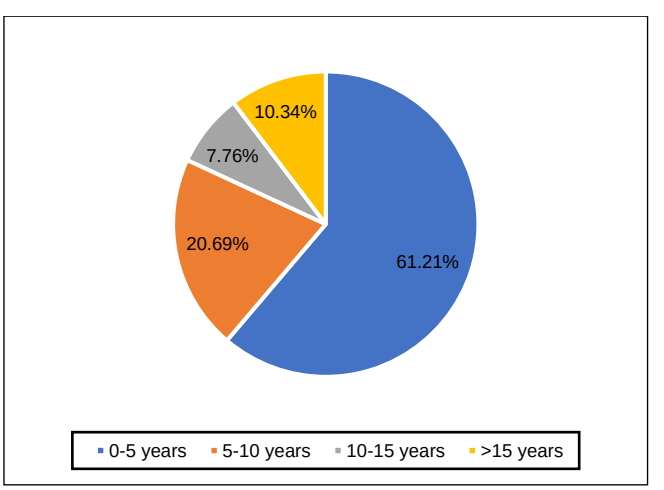

Figure 7. Percentage of Experience in The Construction Industry

Ethnic

From Figure 8, the highest population of workers were others such as Indonesian, Burmese and Bengalese, which includes 90 workers (77.59%). Malay workers have a percentage of 15.52% (18 workers) yet there were only 8 Chinese workers (6.90%) who involved in the construction project.

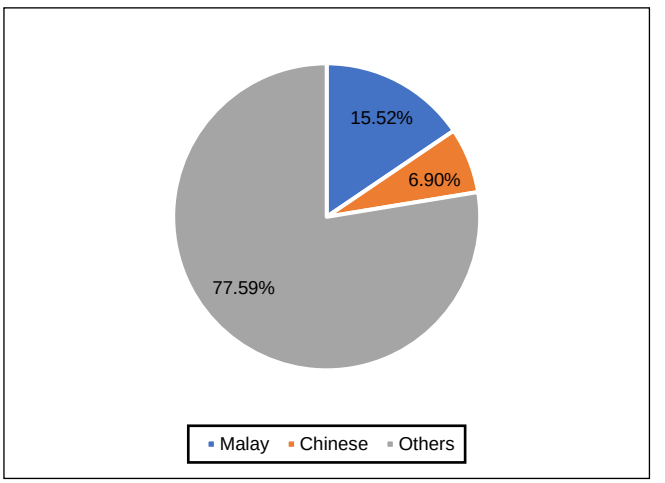

Figure 8. Percentage of Ethnic

Green Card holder

Figure 9 shows the information of Green Card holder. It shows that 61 workers (52.59%) were a Green Card holder. In contrast, 55 workers with a percentage of 47.41% do not have Green Card. Therefore, it could be summarized that worker who have Green Card was slightly more than worker who do not have Green Card.

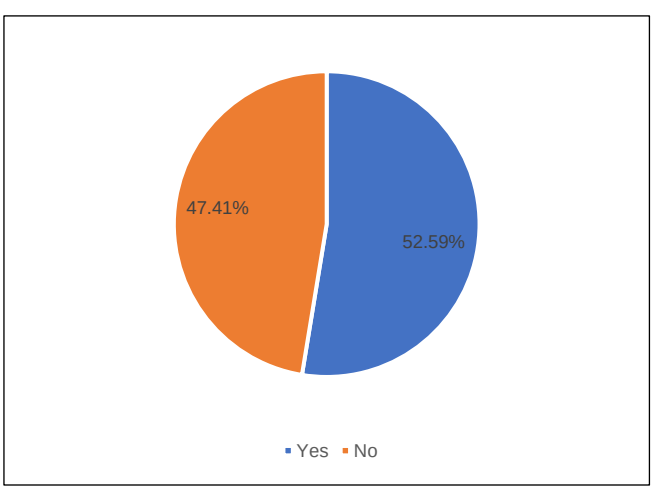

Figure 9. Percentage of Green Card Holder

Analysis: Worker's Safety and Health Status

This section discusses on the worker's safety and health status from the perspective of worker. It includes accident happened during construction project and kind of accident has been experienced or reported. All data collected was measured in frequency distribution and percentage.

Accident Happened During Construction Project

From the overall of 116 workers, accident happened during construction project have been summarized in Table 10. Minority of workers who involved in accident during construction project, which includes 14 workers (12.07%). Yet, 102 workers (87.93%) contributed to no accident happened during construction project.

Table 10. Accident Happened During Construction Project

Accident Happened	Frequency	Percentage (%)
Yes	14	12.07
No	102	87.93
TOTAL	**116**	**100**

Kind of Accident Has Been Experienced / Reported

From the perspective of worker, different kind of accident was identified and concluded in Table 11. Majority of worker experienced accident of not serious and no medical leave with a percentage of 93.10% (108 workers). However, there were 8 workers who involved in minor accident, medical leave not exceeding 4 days and less than 30 days (6.90%).

Table 11. Kind of Accident has been Experienced / Reported

Kind of Accident	Frequency	Percentage (%)
Not serious and no medical leave	108	93.10
Minor accident, medical leave not exceeding 4 days and less than 30 days	8	6.90
TOTAL	**116**	**100**

Comparison Between Contractor's Perspective and Worker's Perspective

This section was discussing on safety and health practices in different sizes of construction project as well as the method for improving safety and health in different sizes of construction project, which were dividing into three aspect such as management commitment aspect, social aspect and risk control aspect. There were several statements within each aspect, which could be identified by Likert scale such as 1 represent strongly disagree, 2 represent disagree, 3 represent neutral, 4 represent agree and 5 represent strongly agree.

Analysis on Safety and Health Practices in Different Sizes of Construction Project

Central tendency has been applied to identify the weightage of the respondent response to each statement as shown in Table 12.

Table 12. Measure of Central Tendency

INDEX AVERAGE	SCALE
1.00-2.33	Low
2.34-3.67	Medium
3.68-5.00	High

Source: Social Research Methods (Bryman, A., 2012)

Table 13. Summary of Management Commitment Aspect in Both Large and Small Construction Project from The Perspective of Contractor and Worker with Its Mean and Scale

NO OF STATEMENT	LARGE CONSTRUCTION PROJECT				SMALL CONSTRUCTION PROJECT			
	CONTRACTOR		WORKER		CONTRACTOR		WORKER	
	MEAN	SCALE	MEAN	SCALE	MEAN	SCALE	MEAN	SCALE
1) Contractor/worker desire a safe working environment	4.40	High	**4.84**	High	**4.40**	High	**3.69**	High
2) Worker participation is the key factor in the implementation of safety and health policy	4.40	High	4.16	High	3.60	Medium	2.93	Medium
3) Organization's safety and health program is effective	4.00	High	4.12	High	3.60	Medium	2.81	Medium
4) Contractor/worker be aware of the possibility of accident occurring at the construction site	4.40	High	4.66	High	4.00	High	2.88	Medium
5) Take action to overcome accident occurring at the construction site is the primary way to enhance safety and health issues among worker	4.40	High	4.38	High	4.00	High	2.93	Medium
6) Worker is provided with safety equipment in accordance with their work	4.40	High	4.81	High	3.60	Medium	3.14	Medium
7) Safety monitoring is conducted periodically throughout the construction project	4.40	High	4.47	High	3.40	Medium	2.71	Medium
8) Penalty will apply to worker who do not comply with safety instruction throughout the construction project	4.20	High	3.71	High	**2.60**	Medium	2.10	Low
9) Toolbox meeting is conducted weekly which related to worker's safety	4.20	High	4.81	High	3.20	Medium	2.78	Medium
10) Use effective communication (either verbal or written) to provide safety information to worker	4.20	High	4.60	High	4.00	High	3.05	Medium
11) Always ensure the safety of worker with strict monitoring by Safety Officer	4.00	High	4.40	High	3.20	Medium	2.76	Medium
12) Safety of worker is the company's priority	**4.60**	High	4.72	High	4.00	High	2.84	Medium
13) Reward/token is awarded to worker who is in compliance with the safety of working on a monthly/periodic basis	**2.80**	Medium	**2.86**	Medium	**2.60**	Medium	**1.91**	Low
14) Ensuring the comfort of worker in both environmental and psychological aspect	3.60	Medium	3.78	High	3.60	Medium	2.62	Medium
TOTAL AVERAGE MEAN AND SCALE	**4.14**	**High**	**4.31**	**High**	**3.56**	**Medium**	**2.80**	**Medium**

Management Commitment Aspect

Table 13 shows the summary of management commitment aspect in both large and small construction project from the perspective of contractor and worker with its mean and scale. Based on Table 13, total average mean from the perspective of contractor and worker in large construction project were in high level, where 4.14 and 4.31 respectively. However, total average mean from the perspective of contractor and worker in small construction project were in the moderate level, where 3.56 and 2.80 respectively.

In large construction project, majority of contractor strongly agree on statement 12 that safety of worker is the company's priority with a highest mean value of 4.60, where 3 contractors. Meanwhile, there was only 1 contractor agree on statement 13 with a lowest mean value of 2.80, where reward or token is awarded to worker who is in compliance with the safety of working on a monthly or periodic basis. Other than that, majority of worker strongly agree that contractor desire a safe working environment with a highest mean value of 4.84, where 49 workers. Meanwhile, minority of worker strongly disagree on statement 13 with a lowest mean value of 2.86, where 3 workers.

In small construction project, majority of contractor agree on statement 1 as well as majority of worker remain neutral opinion with same statement, where the highest mean value was 4.40 (3 contractors agree) and 3.69 (27 workers remain neutral opinion) respectively. Besides, there was only 1 contractor strongly disagree on statement 8 and 13 with a lowest mean value of 2.60. Statement 8 was penalty will apply to worker who do not comply with safety instruction throughout the construction project. Statement 13 was reward or token is awarded to worker who is in compliance with the safety of working on a monthly or periodic basis. Meanwhile, 12 workers remain neutral opinion on statement 13 with a lowest mean value of 1.91.

In short, majority of contractor and worker in both large and small construction project emphasized the significance of safe working environment. This was further supported by Charles (2012) stated that provide a workplace free from hazard could minimize serious harm or death. Other than that, most of contractor in large construction project supported that safety of worker is the company's priority. This was because preventing labour accident, occupational illness and injury should be a primary concern for all employer, which act as an effort for enhancing level of consciousness about the importance of safety and health at the construction site (Kanchana et al., 2015).

CONCLUSIONS

In the conclusion, safety and health practices in large construction project was higher than safety and health practices in small construction project in our country. Throughout this paper, the researcher and reader could be more understanding on the significant of the safety and health practices as well as how to minimize the risk of hazardous situation or accident when different sizes of construction project would be conducted. Even though safety and health practices in small construction project was slightly lower than expectation as compared to safety and health practices in large construction project. However, it proved that still has an improvement space in the aspect of safety and health practices in small construction project in our country.

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A REVIEW OF INTEGRATION MODEL OF LOT-SIZING-SCHEDULING PROBLEM

Hery Irwan[1,2], Md. Nizam Abd Rahman[1], Zuhriah Ebrahim[1] and Raden Achmad Chairdino Leuveano[3]

[1] Faculty of Manufacturing Engineering, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, Durian Tunggal, Melaka, Malaysia.

[2]Department of Industrial Engineering, Faculty of Technical, Universitas Riau Kepulauan, Jalan Pahlawan No. 99, Batam, Kepulauan Riau, Indonesia.

[3]Department of Industrial Engineering, Faculty of Industrial Engineering, Universitas Pembangunan Nasional Veteran, Yogyakarta, Indonesia.

Abstract

One of the most crucial aspects of production planning is the difficulty of integrating lot sizing and scheduling problem. Relationship between lot-sizing and scheduling must be considered simultaneously during planning decision-making to obtain global optimal solutions. Numerous literature studies on integrated lot sizing and scheduling problems, including streaming lot, complex setup, resource constraint, job sequence, and completion date over time, have been published. The objective of this study is to review and identify current research and problem faced in production floor related to interaction between lot sizing and scheduling. Finally, the contribution of this paper goes on to discuss the historical development of the body of knowledge in the subject of simultaneous lot sizing and scheduling, as well as current trends and the extent to which optimization has been applied to this problem.

Keywords: *Integration; lot sizing; scheduling; optimization.*

INTRODUCTION

In last decades, production planning and control research has focused on scheduling strategies and techniques to address production control. The goal of production planning is to figure out the best way to use limited production resources to meet demand over a certain time period. One of the PPC components to improve production control is lot sizing and scheduling. In the traditional hierarchical way of decision-making, decisions about lot size and scheduling are made at the medium-term planning levels, which usually last about six months. However, throughout the entire production process, the market for customer demand could suddenly change (Hu & Hu, 2018). Therefore, Lot Sizing and Scheduling Problem (LSP) still is one of the most essential and hardest challenges in production planning due to complexity of fluctuated demand. It comprises balancing competing objectives in order to optimally allocation resources to fulfil demand and minimizing costs over a planning horizon.

In order to satisfy a given demand estimate over a planning horizon with minimizing costs and subject to capacity constraint, lot-sizing is concerned with deciding when and in what quantity to manufacture each product. Moreover, scheduling is the process of assigning a set of two or more different jobs to one or more machines (resources) over a given period of time (Figueira et al., 2015; Guimarães et al., 2014). In the current production, the traditional hierarchical decision-making process for LSP may be infeasible due to the complex setup and capacity shortages (Mohammadi et al., 2020). Consequently, the integration lot-sizing and scheduling model is routinely developed and applied for determining the optimal global solution to minimise production costs and maximise resource efficiency (Alves et al., 2021).

In this respect Karmarkar & Schrage (1985), has studied continues scheduling several product in a single machine. Fleischmann (1994), has studied LSP on several products discrete on single machine within dynamic demand, (Drexl & Haase, 1995) developed the proportional LSP. Haase (1996) has continue last his and Drexl studied further consider setup state can be set during idle time, and Fleischmann & Meyr (1997), has studied general LSP with consider capacity, inventory and sequence dependent setup as constraint event that integrated of multiple product still on a single machine only. So, more than 20 years not much research specific for general LSP related with current situation real industry. Then from there (Karimi et al., 2003) split them become two categorized there is short period and long period.

Novas (2019), developed LSP model under a constraint programming approach to address a variety of characteristics of the lot streaming problem, including idling, wait/no-wait scheduling, etc., but without considering capacity problem. In production system's resources or capacities include machinery, labour, funding, etc. The concept is referred to be un-capacitated when there are no resource limitations and as capacitated when there are clear capacity restrictions. Limiting capacity has a direct impact on the complexity of the problem. Problem solution will be more challenging when there are capacity restrictions (Karimi et al., 2003). Alimian et al. (2022) recently discussed about integrated the Capacitated Lot Sizing Problem (CLSP) and Capacitated Lot Sizing Sequence-Dependent (CLSD) with consideration of setup times and due dates into the problem of preventive maintenance planning for a multi-stage system.

The LSP usually in short term (operational) and medium term (tactical) is part of planning problems, like minimizing costs (holding cost, setup costs, etc.), lot sizes of production, and production order (Chen et al., 2019). A changeover from one product to another will affect setup costs or setup time in lot sizing problems, but there is a scheduling issue associated with the sequencing of products. This issue become importance if setup time are sequence dependent as the sequence also will influenced into total cost and capacity usage. Thus, might consider for next planning as the lot sizing and scheduling problem should be solved as simultaneously (Copil et al., 2017).

Based on above reason, this paper presents a review of integration LSP model in current issue in production floor while many constraint may consider such as (i) streaming lot size has affect to inventory and another side effect to scheduling, (ii) setup cost rise not only come from changeover product but might also come from tools cost to be provide in every machine, and (iii) optimization way for helping user to solved of complexity LSP to make decision from real cases.

The remaining present of this paper consists of five other sections. The next section shown of literature reviews, describes and presents classification and criteria LSP, describes the scheme for integration lot size scheduling and describe general problem LSP and last section is conclusion or results.

LITERATURE REVIEW

Many articles have been published related with Planning or scheduling. In summary planning for production is an important part of organizing manufacturing. At every step of the process from raw materials to finished goods, production planning was needed to make

sure production goals were met, make the best use of resources, and increase the quality of industrial services (Hassani et al., 2019). At operation level, it's important to stick to the production plan set at the tactical level. This means making the quantities, or lots, set in the plan within a reasonable amount of time and considering the different constraints (Lebbar et al., 2016).

A short review of the research on the LSP in the last ten years is given, with a focus on how setup time and cost depend on the customer's order. The classification and detailed of literature review about the LSP study have given by Copil et al. (2017) and Chen et al. (2019). Meanwhile, Alimian et al. (2022) continued the study by integrating the Preventive Maintenance (PM) planning and production problem at the tactical level. To get more information previous review of discussion about integration lot size and scheduling and applied into uncertainty demand will provided into Table 1. Explored has been done on some databased refer to publication years, subject area, and keywords.

Table 1. Documentary Research Details

Period	Databased	Key words
2012 – 2022	Science Direct Springer Google Scholar	▪ Integration Lot sizing and scheduling ▪ Scheduling with uncertainty demand ▪ Parallel line capacitated ▪ Single line capacitated

Figure 1 presents the number of papers published on the problem of lot sizing and scheduling by year.

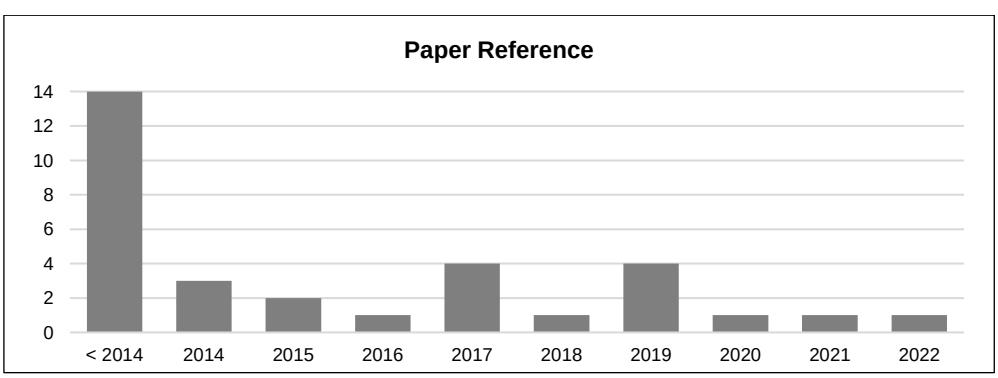


Figure 1. Number of Published Papers Per Year

Table 2 shows history list of literature has published related based on LSP specification.

Table 2. The List of Literature Published Related LSP Specification

Author's	Lot sizing aspects							Scheduling aspects		Productivity				Solutions	
	Planning Horizon	No. of product	No. of levels	No. of machines	Capacity	Demand	Setup	Flow Shop	Job Shop	Inventory	Tools	Despatching	Due Date	Dynamic	Heuristic
Karmarkar & Schrage 1985		M	S	S						•					Branch and bound
Goldratt, 1988		S/M	S	S/M	•				•						
Fleischmann, 1994		M	S	S			•								TSP with time windows
Drexl & Haase, 1995		M	S	M	•	•	•			•					
Haase, 1996		M	S	M			•			•					Mix integer programming
Fleischmann & Meyr, 1997		M	S	M		•	•			•					Greedy algorithm
Aldowaisan & Allahverdi, 1998		M	S	M				•							•
Allahverdi et al., 1999		M	S/M	S/M			•	•	•						
Rajendran & Ziegler, 1999		M	S	M				•					•		•
Potts & Kovalyov, 2000		M	S	S/M			•								
Karimi et al., 2003	•	S	S	S	•	•	•							CLSP	•
Wang & Cheng, 2005		M	S	M			•	•							Branch and bound
Baker & Trietsch, 2009		M	S	S		•						SPT	•		EIT model
Glock et al., 2014			M	M	•	•				•	•				
Guimarães et al., 2014		M	S	M	•	•		•							•
Figueira et al., 2015	•	S	S	M		•	•			•					Mix integer programming
Golmohammadi & Mansouri, 2015	•	S/M		S/M	•				•						
Lebbar et al., 2016		M	M	M				•		•					
Copil et al. 2017	•	M	M	M		•	•			•					
Marichelvam et al., 2017		M	S	M				•				SPT/LPT			Monkey algorithm
Torkashvand et al., 2017		M	S	M					•						
Ye et al., 2017		M	M	M			•	•							•
Hu & Hu, 2018	•	M	M	M		•	•		•	•					multistage stochastic programmin
Chen et al., 2019		M			•		•		•	•					
Hassani et al., 2019		M	M	M			•		•	•					GA & simulated annealing
Mansouri et al., 2019		M	S	S	•										RMA algorithm
Novas, 2019		M	M	M					•	•			•		CP model
Mohammadi et al., 2020		M	M	M		•	•		•	•					Mixed integer LP
Alves et al., 2021	•	M	M	M	•	•	•			•					Hierarchical strategy
Alimian et al. 2022	•	M	M	S		•	•			•			•		Mixed integer non-LP (RH)

**) S = Single / M = Multi*

CLASSIFICATION CRITERIA

The LSP's complexity is driven by the aspects analysed, which influences the design of mathematical models, and the development of computer approaches for solving problems. The fundamental properties of LSPs are depicted in Figure 2 (Chen et al., 2019).

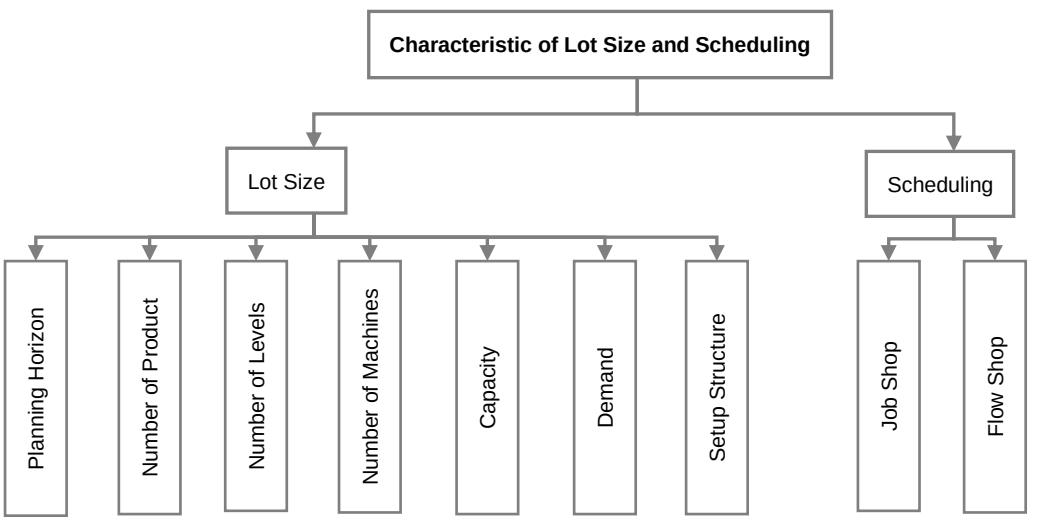


Figure 2. The Characteristics of Lot Sizing and Scheduling Problem

Lot Size Aspects

a) The planning horizon is the span of time, infinite or finite, ahead of which a company's production plan looks.
b) The number of products shows whether production planning takes into account single (single-item) or multiple (multi-item) items. Setups are often part of the multi-item problem, and they are usually modelled by adding a binary variable to the math model (for details, see explanation point g, setup structure).
c) The number of stages or levels shows whether raw materials are converted into final products in one step or in several steps. In multi stages, the outcome of one level become input for the next stage or level.
d) The number of machines shows if the environment has a single level of production, where a single machine or several machines working in parallel can be used, or if it has multiple levels of production, where a single machine or several machines can be used at each level.
e) Independent demand in the single-level model, it is derived from market forecasts or customer orders. In multi-level models, it is figured out by adding up the external and internal needs of each product, taking into account how they relate to their parents and other parts. Demand can be either determined (with values that stay the same or change over time) or random.
f) Capacity takes into account the explicit allocation of limited resources, such as machines, equipment, money, people, etc. The capacity limit set is important because it makes the model more like the real world and makes the problem more difficult. The problem is said to be un-capacitated when there are no limits on the resources that can be used.

g) Setup structure is linked to production of more than one item, where switching between products can cause setup costs and/or setup times. It has structures that are independent of sequence and structures that depend on sequence. It is modelled with attribute values, which makes solving problems much harder.

Scheduling Aspects

a) Job shop scheduling is the process of putting n jobs with different processing times on m machines. Depending on the details of each job, there can be different ways to process it (Torkashvand et al., 2017). Based on job shop system literature review on specific master production scheduling, we investigate six stated to influence throughput characteristics in three categories: setup time, capacity constraint and complexity of operation. The variables in each category are described in detail below:

- Operational complexity. According to Goldratt, (1988), the complexity of procedures is influenced by two things. These characteristics include the complexity of the flow and the number of commodities used by the same equipment. Golmohammadi & Mansouri, (2015) demonstrate that operation complexity has a significant impact on actual throughput and develop a complexity index based on the number of products that require to process into the machine. This index not only captures product-machine dependencies, but also the entire number of paths to the machine, including cyclic and loops processes. The number of complicated machines determines the amount of complexity (denoted by Complexity Level) in a task (Mansouri et al., 2019).
- Capacity shortage. Many researchers claim that a lack of capacity is one of the most important variables influencing the realization of expected throughput (Golmohammadi & Mansouri, 2015); As a result, we divide capacity shortage into two categories: low and high, to classify challenges in this area. If more than half of the machines are unable to satisfy demand, the capacity shortage is considered high; otherwise, it is considered low (Mansouri et al., 2019).
- Setup requirements. We include setup needs as additional factor that can influence the actual throughput. In leveraging the available time on machines, problems with setup are more uncertain (Baker & Trietsch, 2009). The preparations that can only be made when the machine is not in usage are referred to as setup. Minor setups (like setup in a CNC machine need to change the tools) and off-line are not included in this category. Finally, in the mixed-effects model, a binary variable can be used to represent the setup.
  Using a simulation study, it was found that sequence-dependent setup times are a very important part of how well a job shop works when it is at or near full capacity. In this review, we have focused on how to solve static scheduling problems, but research into dynamic scheduling problems has been focused on making and testing dispatching rules (Allahverdi et al., 1999).

b) Flow shop scheduling is a type of job shop where all jobs are done on machines in a certain order (Marichelvam et al., 2017). Particularly, when all jobs are the same, the machines can be treated as a single machine or as parallel machines (i.e., when they must all go to the same machines in the same order). In the flow shop application m-machine, jobs that come in must be done on m machines in the same order of

technology. Each job has m operations, and operation *i* of each job is to be done on machine *i*. Different machines may have different operating times for each job (Allahverdi et al., 1999).

CLASSIFICATION SCHEME FOR SIMULTANEOUS LOT-SIZING AND SCHEDULING MODELS

Decision "why" we need to apply lot sizing on our manufacturing process due to related with setup time or setup cost. Since setup is one necessary activity during the process but not value added, so that activity can't be remove from the process but in practical process need to reduce. Reducing setup time only can be apply by manage setup time happen in manufacturing. Based on maximum number of setups in period has 2 models classified, there is called "small-bucket models" and "large-bucket models". Both models can differentiate like small-bucket used at most one setup per periods and large-bucket may more than number of setups applied on periods. Small-bucket had several classes model, there are *the continues setup lot sizing problem* (CSLP), *discreate lot sizing and scheduling problem* (DLSP), and *the proportional lot sizing and scheduling problem* (PLSP). For long-period used *the capacitated lot-sizing problem with sequence-dependent setups* (CLSD) and *the general lot sizing and scheduling problem* (GLSP). All models mentioned support lot sizing as well as scheduling decisions with the objective to minimize for all setup and holding costs and consider due date and capacity limitation (Copil et al., 2017). Relations between model classes can be shown in Figure 3.

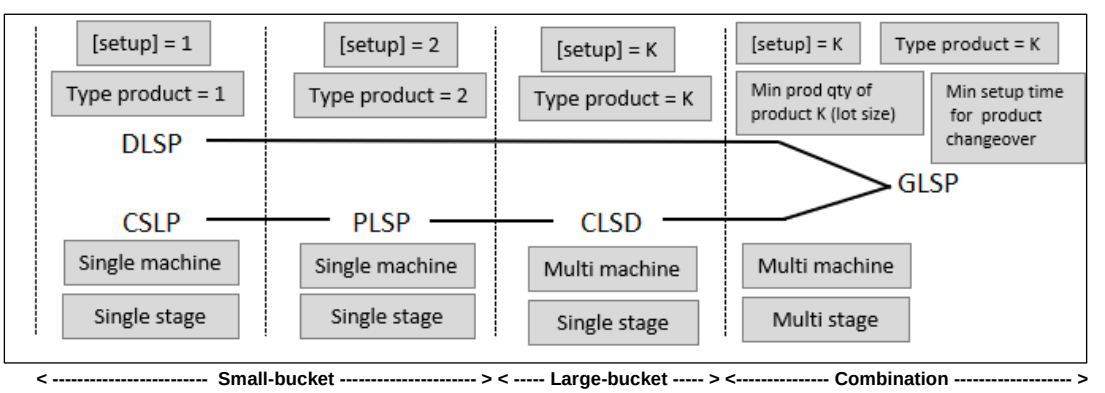
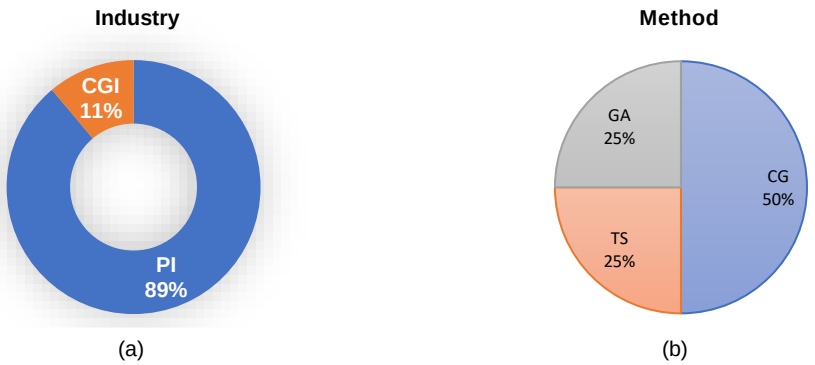


Figure 3. A Classification and Relationship Model

Discrete Lot-Sizing and Scheduling Problem (DLSP)

It highlights the fact that the sizes of the generated lots are always multiples of the period's capacity in integers. This fact is supported by the all-or-nothing assumption and the presence of the DLSP model on a tire maker. A company that makes tires has to think about multiple products with changing demand that are made on the same machines in parallel. Setup times is ignored. DLSP model was discussed earlier applied into process industry and consumer goods industry, but very rear due to some researcher only review without solving the issue like Column generation (CG), Tabu Search (TS) and Genetic Algorithm (GA). The distribution can be shown in Figure 4.

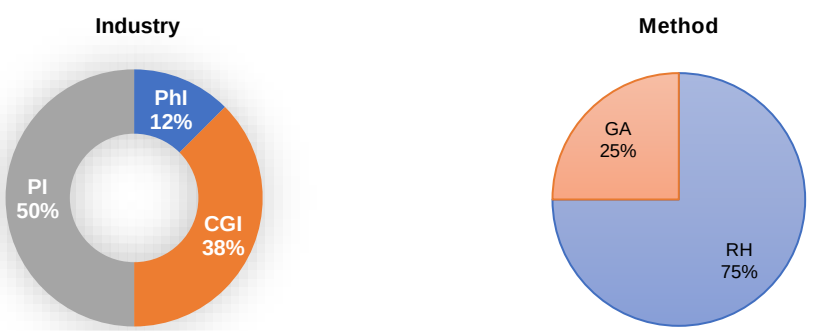


(a) (b)

Figure 4. Overview Industry (a) and Method (b) Implemented DLSP

Continuous Setup Lot-Sizing Problem (CSLP)

The CSLP is a small bucket model, which means that each period only has a small number of different products. Earlier researcher had discussed CSLP into Pharmaceutical industry, consumer good industry and process industry. To solve the problem used Rolling Horizon (RH), Fix and Relax (F&R) and Genetic Algorithm (GA). The distribution can be shown in Figure 5.



(a) (b)

Figure 5. Overview Industry (a) and Method (b) Implemented CSLP

Proportional Lot-Sizing and Scheduling Problem (PLSP)

In practice, usually the length of a period will be short because one setup can be used at any time during a period, which means during a period at least two kinds of products can be process or made. This PLSP mark as a small-bucket model. The method solves using regret based, backward oriented, and random sampling method. The problem counted from the last period then moving backward until beginning period. Randomize regrets are used. Researcher had done tested PLSP into some industry like chemical industry, consumer goods industry, process industry, pharmaceutical industry, and electronic industry. Those study cases were solved thru Genetic Algorithm (GA), Fix and Relax (F&R) / Fix and Optimize (F&O) and Mix Integer Programming (MIP). The distribution can be shown in Figure 6.

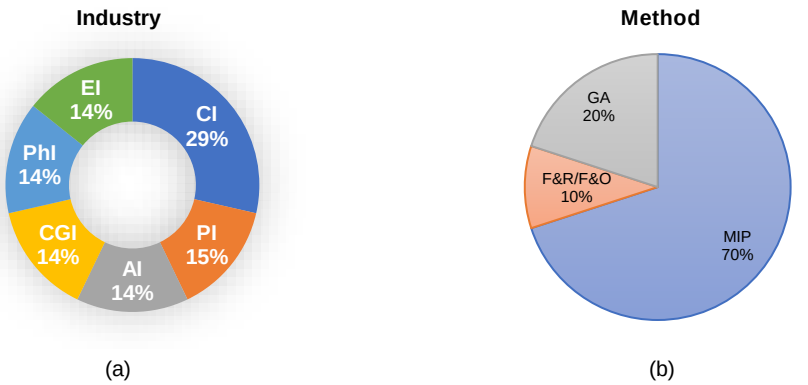


Figure 6. Overview Industry (a) and Method (b) Implemented PLSP

Capacitated Lot-Sizing and Scheduling with Sequence-Dependent (CLSD) Setup Problem

CLSD model is another simultaneous lot-sizing and scheduling using large-bucket model formulation. The lots sequence within small-bucket is modelled based on travelling Salesman problem (TSP), thus a product can be produced at most once per long-period. In the single-stage, parallel machine model, multiple products can be produced over a long period, but a minimum of N setups must occur each period and machine. Much research had done by applied CLSD models into consumer good industry, semiconductor industry, process industry, food industry, beverage industry and animal food industry. Majority cases was solved using Mix Integer Programming (MIP) and Fix and Relax (F&R) method. The distribution can be shown in Figure 7.

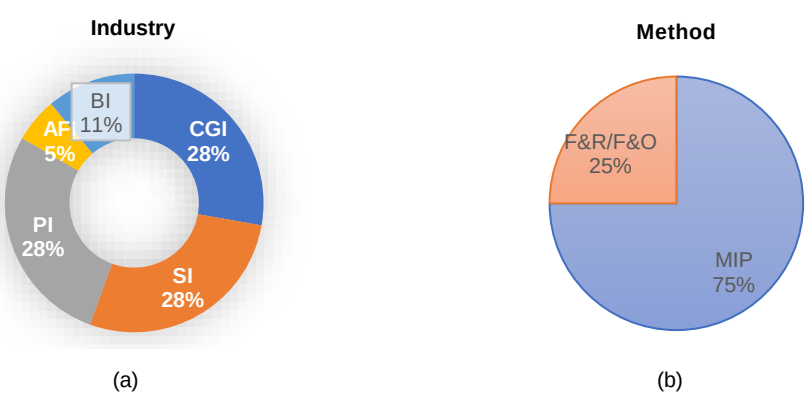


Figure 7. Overview Industry (a) and Method (b) Implemented CLSD

General Lot Sizing and Scheduling Problem (GLSP)

GLSP models or another name is hybrid models due to GLSP has combine large-bucket and an approaching to sequence the lots. GLSP was improve by extend with generalized the other model because each of these basic models can be shown as a special GLSP case in production for a single resource with a limited amount of capacity. Some research has discussed GLSP models applied into food industry, consumer goods, beverage industry,

semiconductor industry, process industry and animal food industry. Most of them was solved using Mix Integer Programming (MIP) and Genetic Algorithm (GA). The distribution can be shown in Figure 8.

(a) (b)

Figure 8. Overview Industry (a) and Method (b) Implemented GLSP

In continues research GLSP model has develop for become "generic" version since GLSP applied and consider more than one capacitated production resources. The model formulation of GLSP- generic as stated below (Copil et al., 2017).

$$\text{Min} \sum_{s=1}^{S}\sum_{i=0}^{K}\sum_{k=0}^{K} sc_{ik} \,.\, z_{iks} + \sum_{k=1}^{K}\sum_{t=1}^{T} hc_k \,.\, I_{kt} + \sum_{k=0}^{K}\sum_{s=1}^{S} pc_k \,.\, q_{ks} \qquad (1)$$

i, k = *Product -i, and k = 0, 1, …k whereas 0 is the initial state*
s = *small bucket, and s = 1, 2, ….s*
t = *large bucket, and t = 1, 2, ….t*
S_t = *Setup requires for small bucket s within large bucket t*
sc_{ik} = *Set-up costs raise from changeover product i to product k*
hc_k = *Cost rise for inventory if product k>0 (per unit and per small bucket)*
pc_k = *Preserve cost raised when set-up need to be done for product k on the machine or resource (per time unit)*

THE GENERAL PROBLEM OF LOT-SIZING AND SCHEDULING

Single-Machine Problem

Arriving jobs required from single available machine. Jobs performed by the machine one at a time and each job may have different process time, setup time, weight, and due date. Another important type of scheduling problem is to separate the time it takes to set up a job from the time it takes to do the job. This is especially important when the set-up time is a big part of the total processing time. When setup times are kept separate from processing times, a job may take less time to finish because the setup time for the next job can be done while the machine is not being used. When setup times are added to processing times, this reduction in time to finish won't be possible (Aldowaisan & Allahverdi, 1998); (Wang & Cheng, 2005).

Parallel-Machine Problem

Jobs that come in can be done on any of the machines that are available. Each job has a single step that can be done on any machine. This step is different for each job. In many real-world situations, the goal of scheduling to minimize total flowtime is more important than the goal of minimizing makespan. This is especially true when it comes to minimizing inventory or holding costs. In the same way, the goal of scheduling is to reduce the number of jobs that are late. This is because being late can lead to a contractual penalty of late delivery and loss of customer goodwill (Rajendran & Ziegler, 1999).

Formulation for no-wait two-machine flow shop, the completion time can be defined as below and following Gantt chart for illustration can see on Figure 9.

$$C_{[1]} = \max\{s_{[1],1} + t_{[1],1}, s_{[1],2}\} + t_{[1],2}, \quad (2)$$

$$C_{[2]} = \max\{C_{[1]} + s_{[2],2}, + C_{[1]} - t_{[1],2} + s_{[2],1} + t_{[2],1}\} + t_{[2],2}, \quad (3)$$

$$C_{[3]} = \max\{C_{[2]} + s_{[3],2}, + C_{[2]} - t_{[2],2} + s_{[3],1} + t_{[3],1}\} + t_{[3],2}, \quad (4)$$

In general

$$C_{[j]} = \max\{C_{[j-1]} + s_{[j],2}, + C_{[j-1]} - t_{[j-1],2} + s_{[j],1} + t_{[j],1}\} + t_{[j],2}, \quad (5)$$

where $C_{[0]} = t_{[0],2} = 0$

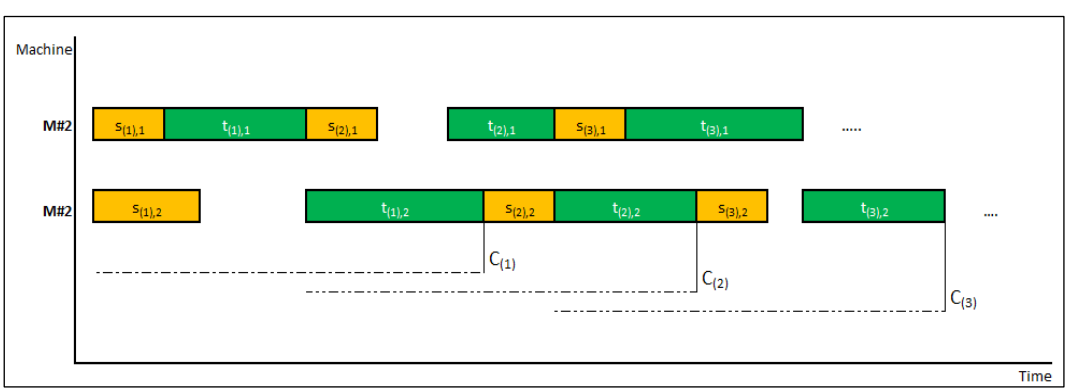


Figure 9. Gantt Chart Illustration of Completion Times for Two-Machine

t_{ij} = *Job processing time (i,j) to complete on machine n*
S_{ij} = *Setup time (i,j) required for job on machine n*
C_n = *Job completion time(i,j) when finish on machine n*

No-wait flow shop production is used a lot in manufacturing, where there is no time for waiting between two processes. Makespan, also called maximum completion time, is the amount of time it took to finish the last job on the last machine. This shows how well the facility was used. One of the most important goals of no-wait flow shop production is to reduce the makespan, min (Cmax) (Ye et al., 2017).

Lot-sizing models determine ideal order and/or production numbers, which in turn influence inventory levels and, as a result, a company's responsiveness. Because these

decisions are influenced by the consequences of item production, transportation, and storage, it is evident that issues impacting inventory system productivity should also be considered, as they have a direct impact on how inventory is built and maintained over time (Glock et al., 2014).

Batching can be helpful when machines need to be set up in a certain way before they can handle jobs with different characteristics. The set-up may show that a tool needs to be changed or that the machine needs to be cleaned. In a scheduling model family, jobs are put into groups based on how similar they are. If a job is in the same group as the job that was just done, it doesn't need to be set up again. But there is a setup time required at the beginning of schedule and every time when machine doing changes jobs from one family to another family. In this model, same jobs will put a same batch to be plan run or process into same machine at the same time and share the same setup. Since there are fewer setups for large batches, the machines can be used more efficiently. On the other hand, to process batch with big size make it take longer to finish job as important from a different family (Potts & Kovalyov, 2000).

Researchers have looked at inventory system productivity from many different aspects, such as learning effects, random yield, and deterioration. When people, teams, or organizations get better at what they do over time, this is called a "learning effect." The better performance could be due to better use of tools and machines, more familiarity with operational tasks and the work environment, and more effective management. Learning in production reduces system inventory, which leads to bigger lot sizes. On the other hand, learning in setups lowers setup costs, which leads to smaller lots and more setups (Glock et al., 2014).

Optimization Design

The right choice of parameters is one of the most difficult parts of both genetic algorithms and simulated annealing. The design factor for a generic algorithm, you need to think about four parameters: the size of the population, the maximum number of iterations, the chance of crossover, and the chance of mutation. There are 2 parameters additional for simulated annealing from first four was mentioned earlier. That is additional parameters are cool rate α and temperature T. Furthermore, to effectively manage the evolutionary simulated annealing and algorithm, the Taguchi method should be used because that design method can improve productivity (Hassani et al., 2019). To figure out how much the variables already change, the S/N (Signal to Noise) ratio will be used as an indicator of change. To study the ratio S/N, there are three types of performance: small-the-better, nominal-the-best, and large-the-better (Taguchi et al., 2000). Mostly production target from integration lot sizing and scheduling is total cost while the S/N ratio will measure use small-the-better because smaller. Represent for the fitness value as below:

$$\frac{S}{N} = -10log10\left(\frac{1}{n}\sum_{i=1}^{n}\frac{1}{y_1^2}\right) \tag{6}$$

n = *Number of observations*
y = *Variable of response*

CONCLUSION

Jobs that are similar and use the same set-up can be grouped together. The batching machine concept, on the other hand, puts jobs together so that they can be completed all at once. Analysis of these models shows that sometimes the order of jobs and how they are done in groups can be separated. Dynamic programming is demonstrated to be an effective method for resolving the batching problem once the order of jobs within a family (in the family scheduling model) is known. Integrated lot-sizing and scheduling by simultaneous is many industrial applications drive research in a field that is doing well. Most of the time, these applications are made up of a one-stage or two-stage production system with one or more mostly different machines per stage. Some that application originally on consumer goods industries including food and beverages. For solution techniques related integrated lot-sizing and scheduling almost all model mentioned above for last research had using GA. When considering the CLSD and GLSP models is more applicable for some real industrial characteristic.

Most researchers have come up with a set of heuristic-based mathematical models to solve LSP. It's the meaning, that problem categorized is NP hard but still need to continue for future research to develop model robust for schedule machine applicable for all manufacturing type, and that able to consider and calculate how many inventories allow as space constraint, lateness as capacity constraint or part need send to subcontract to help better delivery and minimum penalty and opportunity cost. The relationship between modelling and algorithms will be interesting discussion by additional characteristics, including as lead time, backlogs, and related real-case data, as possible additions to delivery time, cause models to get bigger and more complicated, so we must use sophisticated algorithms for problem solving.

The schedule with quantity in lot size, various job and different due date for each job, the choices best method will be effect to completion time. Beside of that dispatch rules and routing have contributed to optimization result since due date every job is different. To support planner making faster decision need software to do simulation for best optimization.

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QLASSIC FRAMEWORK ON DEFECTS IN HIGH RISE RESIDENTIAL IN MALAYSIA CONSTRUCTION INDUSTRY

Nisamini Subramaniam[1], Roshartini Omar [1,2], Norliana Sarpin[1,2], Mohd Nasrun Mohd Nawi[3] and Aina Mardia Sallehuddin[4]

[1]Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor, Malaysia.

[2]Centre of Sustainable Infrastructure and Environment Management (CSIEM), Fakulti Pengurusan Teknologi & Perniagaan, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor, Malaysia.

[3]UUM College of Business, School of Technology Management and Logistics, Universiti Utara Malaysia, Sintok, Bukit Kayu Hitam, Kedah, Malaysia.

[4]Naza Engineering Construction Sdn. Bhd. Jalan Judo 13/45, Seksyen 13, Shah Alam, Selangor, Malaysia.

Abstract

Malaysia continuously registered positive growth in the construction industry. The development of the construction industry increases buyer perception on Malaysia projects. The higher the quality achieved in building projects attracts the attention of buyers. Residential projects are considered the highest type of construction industry, which grows with the high number of buyers and investors. However, high-rise residential house owners have quality issues in terms of defects in their units among the residential projects. The defects which occur in high-rise residential stand in different types of categorizing. Thus, this research carries the objective to developing a framework on QLASSIC to reduce defects in high rise residential projects with data collected from respondent of Malaysia private residential developers whom have been won QLASSIC Achievement Awards from year of 2015 until 2019. This study will be helpful to identify types of defects and control the root cause of defects in high-rise residential. Defects have to be at the control level to remain of good quality in our high-rise residential project.

Keywords: *Defect; high rise residential; QLASSIC; construction.*

INTRODUCTION

Defects occurring in the building are referred to as flaws in a construction project. Defects are frequently identified later, or during an investigation into one or more of the defect's side effects. According to Aliyu (2020), problems in Malaysian high-rise residential projects continue to fall short of client expectations, with the majority of structures exhibiting flaws as a result of insufficient construction materials and flawed architecture. Hang (2016), the new house, is poorly constructed, and new customers are regularly complaining about their units. Inadequate quality, bad materials, and a lack of control, according to prior studies, were the causes of building project defects. Defects are defined as failures in a structure's operation and output. Despite the same contractor rebuilding the house, defects keep reappearing and repeating rectification.

Managers in Malaysia should concentrate on building parts, material collecting, and quality craftsmanship to address defect issues. Civil engineers, as opposed to mechanical engineers, can better monitor problems (Suffian, 2016). According to the Malaysian National House Buyers Association, 65 percent of clients are dissatisfied with the state of their new apartments due to the high number of problems (Curtis, 2018). Thousands of complaints were received from home buyers who were dissatisfied with the state of defects (Chang, 2018).

Suppose there is a defect in the new property. In that case, the housing developer is required to give a defect liability period (DLP) for repair work under Sale and Purchase Agreement (SPA). In this circumstance, over the last five years, the Ministry of Housing and Local Government has received between 2,400 and 4,500 complaints on defects (Ahmad, 2018).

Many of the lawsuits were judicial battles over developer compensation. Aside from that, the National Housing Tribunal received 6,534 defect complaints. According to Housing and Local Government, the instances concerned technical allegations. According to Razak (2016), Malaysian buyers struggle to acquire a high-quality project with a low number of defects. Buyers reported a high number of problems in newly constructed residential developments, which required rectification work. Architectural (63 percent), mechanical (19 percent), electrical (15 percent), and civil (3 percent) problem complaints have been received in Malaysia (Suffian, 2016). According to Ahmad (2013), waterproofing issues, cracks, soil settlements, wall finishes, and staining are all common defects that developers face. According to Hang, clients with defects include faulty electrical wiring or equipment, ineffective or unsafe ventilation systems, cooling or heating systems, and insufficient fire protection. Bad material use, failure to follow specifications, a lack of oversight, and a lack of time workforce allocation may all contribute to these types of defects (Hang, 2016). Defects are caused by incorrect levelling, a lack of security, faulty construction and any function that does not meet specifications (Zakaria, 2016).

LITERATURE REVIEW

Philips B. Crosby first explored and created the concept of flaws in the 1960s. His belief in 'Zero Defects' is well-known. It all started with the Martin Marietta Corporation in the United States. In order to be implemented in real-world ventures, the zero-defect theory requires four components. Quality is a condition that confirms the existence of requirements. As a result, zero-defect in a venture signifies that all requirements have been met. The first run-through is extremely important (Leong, 2020). Rather than addressing concerns later, quality should be built into the engagement from the start. Apart from that, quality is judged in terms of money. One of the prerequisites is to make a budgetary judgment on waste, creation, and revenue. The accepted principles should be used to determine execution, which should be as close to faultless as possible.

Disintegration, losses, default, or inadequacy are all examples of flaws in building projects, according to Aziz (2015). The phrase "damages" refers to both visible and concealed hurts. The undeniable issues can be found quickly, but the hidden flaws will take a few years to uncover. According to the expert, development flaws can be defined as a disappointment or inadequacy in the structure's capacity, execution, legal, or client requirements. Nonetheless, other types of flaws in development programs are possible. Honeycomb, roofing faults, erosion of mortar joint, foundation collapse, peeling paint, and timber rot are all surrenders, according to Olanrewaju (2015).

Defects can occur at any time during the planning process and ahead of the development timeline. It could happen for any cause. The regular referred to numerous factors for deformity include helpless workmanship, material determination, inadequate designs, and management. This issue has been studied further to show that flaws can be caused by a lack of ability, insufficient employees, poor work execution, and a lack of site development studies (Milion,

2017). The occurrence of flaws may impact a client's opinion of developers. They will not trust the same developers again because of their previous experiences. Defects can also lead to construction failure and large-scale disasters.

METHODOLOGY

A conceptual framework was developed based data collected from Malaysia private residential developers whom have been won QLASSIC Achievement Awards from year of 2015 until 2019. Table 1 illustrate number of company and respondents involved in this research. Seven private developers with total of 35 respondents were involved in the case study. Inside the organisations, interviews were performed with three levels of management: upper, centre, and lower management. This research undergoes multiple holistic design case study which involve multiple case studies with single unit analysis. Semi structured interview method used to investigate trends that surfaced as a result of the usage of interviewer que.

Table 1. Number of Company and Respondents

Type of Company	Interview Respondents	Percentage (%)
A	5	14.3
B	4	11.4
C	5	14.3
D	5	14.3
E	6	17.1
F	6	17.1
G	4	11.4
Total	35	100

TYPES OF DEFECTS

Table 2. Type of Defects in High-Rise Residential Projects

Type of Defects	COMPANY							Number of Respondents
	A	B	C	D	E	F	G	
Structural defect	0	2	1	1	2	1	1	8*
Architectural defect	2	1	0	1	1	3	1	9*
Mechanical and electrical work defect	2	0	3	1	2	2	1	11*
External work defect	1	1	1	2	1	0	1	7*

Table 2 shows the results of type of defects in high rise residential projects which proposed by respondents. The types of defects which came out after the analysis are structural defect (22.9% 8 out of 35), architectural defect (25.7% 9 out of 35), mechanical and electrical work defect (31.42% 11 out of 35) and external work defect (20.0% 7 out of 35). According to Chan (2019), there are four different types of defects. There have been four types of defects: structural, architectural, mechanical, and electrical, as well as external works issues. QLASSIC is being used by the Malaysian building sector in residential projects. QLASSIC is a method for evaluating the quality of workmanship in construction projects. This should be supplied in addition to the typical contractual sketches and dimensions for the project (Paul, 2013). It is not intended to be used as a stand-alone working standard. Contractors must conform to the consultants' professional standards in particular. The Superintendent Officer is also responsible for ensuring that the building's efficiency satisfies the authorized specifications, processes, measurements, and plans, wherever they may be. In general, there

are four primary components to the Quality Assessment System for Building Construction Work (Ali, 2016). This includes work on the structural, architectural, mechanical, and electrical systems and work exterior.

Structural Work

A defect or deviation from the anticipated structural performance of a construction element is referred to as a structural defect. A structural defect is actual physical harm to the home's designated load-bearing elements brought on by their failure to perform their load-bearing duty to the extent that the structure becomes unsafe. The structural issues that were looked into in this study were spalling, loose plaster, or concrete with defects on the roof or ceiling. These problems are brought on by seepage or leaks from the slab roof (Chew, 2015). These flaws cause bulging, pattern cracking, and the removal of the concrete's clear layer, revealing the reinforcement.

The support rusts due to corrosion, and plaster or tile delamination might occur when water leaks interact with the walls nearby. water seepage via a window, roof, or ceiling. Water stains, paint or wallpaper peeling and discolouration, water dripping, and fungus growth can all be caused by water seepage from gaps in exterior walls. Permeable concrete, plaster, and tiles would all develop defects as a result. Stains induce water seepage in buildings, which can be brought on by a number of things like cracked exterior walls, honeycomb, subpar concrete, bad windows, and a leaking waterproofing membrane on the roof (Enhassi, 2015). Numerous factors, such as soil settlement, foundation overloading, shoddy design and construction, or the use of subpar materials, can cause structural fractures to appear. Cracks that extend through finishes into the bricks include those that run the length of the wall, diagonal fractures at window or door corners, and cracks stained with rust. plaster or other finishes with a cement or rendering substrate that have non-structural fractures. Typically, this kind of crack simply serves aesthetic objectives and does not present a safety hazard. Examples of this sort of crack include hairline cracks, multi-directional shrinkage cracks, and cracks between panel walls and structural components (Hew, 2018). Inadequate stone cladding, tiles, or wall treatments. These flaws may manifest gradually as a result of ageing, subpar construction, thermal movement in expansion joints, or outside factors like falling objects. When a hammer is pounded against it, the effect is a hollow sound because this results in the de-bonding and delamination of finishes and tiles from the structure.

Architectural Defect

The design of a building as expressed in any concrete medium of expression, such as a building, architectural plans, or drawings, is referred to as architectural work in construction. Architects produce designs and concepts by visualizing the building structure and discussing it with engineers. For a more accurate cost estimate, both architects and engineers must assess material costs and building time. The term "major defects in architectural works" refers to walls, floors, and finishes. Water seepage, plaster cracks, uneven floor levels, floor tiles that have come loose, and floor tile cracks Wall, floor, and finishing flaw defects include pebble wash not provided, fungus, inappropriate wall tile fastening, divider not provided, and skirting removed (Hong, 2018). Non-functional windows, unclean windows, damaged window ironmongery, unfinished window installation, blinds not provided, and corroded windows are all considered flaws under window and fittings. Architectural flaws under the door and fittings

include door damage, ironmongery damage, unfinished ironmongery installation, door key not provided, untidy door painting, non-functional door, disconnected door stopper, peeling paint at door, doorknob inverted, and door frame damage (Shittu, 2015). Ceiling finishing defects include perforated ceilings, ceilings that are missing, leaks, ceiling fungus, and stain marks on the ceiling (Jaafar, 2018). Sanitary Fittings, Fixtures, and Toilet Cubicles faults include incomplete installation of fittings, leakage, blockage, detached sanitary fittings, non-functional floor trap, water closet cover damaged, improper installation of fittings, cistern overflow, and flush damage.

Mechanical and Electrical Defects

Any building service that uses machines is referred to as a mechanical system. Plumbing, elevators, escalators, and heating and air-conditioning systems are among them. Modern buildings have reduced central heating to a supplement with their huge heat gains. Power transformers and other electrical equipment have delicate componentry that, if faulty, can result in catastrophic asset failure (Ling, 2016). Power transformer failures pose a significant risk to the entire facility and trigger costly shutdowns that reduce plant operations and limit capacity. Many typical types of electrical faults, such as partial discharge, arcing, hot Spots, loose connections, and static Electrification, are caused by insulation degradation, overheating, surges, mechanical moisture defects, and other reasons (Khoury, 2019).

Bus bar faults are a form of mechanical and electrical failure. Bar bars are important parts of the electric power distribution system because they connect high-voltage equipment. Bus bar failures can have a significant impact on plant operations and the ability to disrupt the entire power distribution network. Insulator failures, pollution, overvoltage, and failure of associated equipment are all common causes of bus bar problems (Milion, 2017). Any critical asset located within the refinery or process plant environment might be affected by process problems. Process faults comprise any ensuing problems in tooling equipment that may develop due to refinery equipment being subjected to tremendous stress daily. Process faults can occur in your facility due to internal and external problems, as well as user errors in any technological procedures, affecting a number of assets such as motors, pumps, other rotating equipment, and piping systems (Othman, 2015).

External Work Defects

External works refers to the areas immediately surrounding the structure and includes secondary roads in a housing estate, paved areas, boundary walls, railings, fencing, and turfed areas, among other things (Ramly, 2015). Exterior works refer to any characteristics used to complete a project's external environment, whether it's a residential, commercial, industrial, or community project. In most projects, external features are required to assure the end product's functionality and offer value. Defects at linkways, shelters, drainage, road works, car parks, footpaths, turnings, playgrounds, gates and walls, swimming pools, hardscapes, and electrical substations are considered as defects in eternal work.

CAUSE OF DEFECTS

Table 3 shows the results of cause of defects in high rise residential projects which proposed by respondents. Causes of defects are stand from faulty design (48.6% 17 out of 35), cost (34.3% 12 out of 35), poor workmanship (17.1% 6 out of 35), poor material (8.6% 3 out of 35), miscommunication (14.3 % 5 out of 35) and poor supervision (11.4% 4 out of 35).

Table 3. Cause of Defects in High Rise Residential Projects

Cause of Defects	COMPANY							Number of Respondents
	A	B	C	D	E	F	G	
Poor workmanship	0	2	1	1	0	0	2	6*
Poor material	1	1	0	0	1	0	0	3*
Faulty design	2	0	3	3	3	5	2	17*
Poor supervision	1	1	0	1	0	1	0	4*
Miscommunication	0	1	1	0	1	1	1	5*
Cost	1	0	1	2	4	3	1	12*

Poor Workmanship

Developers have always demanded skilled personnel to complete a successful construction project. Workmanship issues are a problem for both hired subcontractors and major contractors. According to Harun (2015), some project workers are also eager to hire inexperienced laborers to save money on professional remuneration. The Malaysian government has been attempting to improve laborers' knowledge and expertise through various factors such as field preparation, workshops, and short courses. However, the project team responds to them less frequently (CIDB, 2018). It suggests that the vast majority of workers for hire are unconcerned about it and still have a low level of awareness of the nature of development. Issues including inappropriate material installation, incorrect curing, bad plumbing, and inadequate soil settlement inspection can result from poor workmanship. The quality of construction projects may be impacted by this condition and may result in many different types of problems. Malaysia's minor construction enterprises are categorised as Class F, according to Suffian (2016), and are only allowed to complete projects that are valued less than MYR 200,000.00. However, due to inexperienced workers and limited input from outside parties, job productivity is low.

Poor Materials

According to Rosli (2013), a major portion of the structures in Malaysia use locally created and accessible building materials. The concept of building materials should be understood in the material management of constructions. To avoid flaws, modelers, hired employees, specialists, and everyone else involved in the building should pay close attention to the proper use of materials and construction, as well as a deeper understanding of the legal procedures. According to Razak (2016), high-quality materials are more durable. When a hired worker uses high-quality materials, for example, the higher grade of the total is used as the foundation for a robust project. In the current situation, the base's durability and strength will be of the highest quality, and buyers will have no need to be concerned about any flaws, and it will also be incredibly safe. Apart from that, when contractors use poor materials in

construction, it may frequently lead to defects (Wood, 2014). This may affect their reputation and satisfaction level of the customer on developers.

Faulty Design

Cost is always a major consideration in the task's planning. To save money on building, a typical design error is committed. This is a common occurrence when portions and support bars and restaurants are reduced in size. A developer can save money at the start by developing a blunder plan, but as the project progresses, they may run into a slew of complications that are the result of the blunder plan (Fang, 2016). It may result in later vulnerability situations when the design is unable to withstand the heap and finally collapses. When portion sizes aren't right for a portion, a bad strategy might lead to problems (EPA, 2013). According to Ishak (2017), a proper strategy can help to eliminate workmanship absconds and reduce the degree of fault. Laborers will have adequate guidance and methodology to finish the task if a suitable plan is used. To put it another way, well-prepared design and drawings can make projected works more effective, and defect-repair work can be completed faster. The flawed design, according to Ying (2016), would result in defects. Design flaws endanger the structure of a building and the people who use it, as well as raise the expense of upkeep when repairing flaws (Jaafar, 2018).

Poor Supervision

In both small and large development projects, supervision plays an important role. In addition to being guided in each errand, supervision plays a role in preventing mishaps on the construction site. Aside from that, regular supervision involves planning, allocating tasks, determining, verifying execution, fostering collaboration, and ensuring labour force participation (Dang, 2018). According to Ying (2016), the most common causes of wounds in the development business were a lack of management and helpless craftsmanship. When looking back on constructing disappointment cases, the majority of the time, it is due to helpless oversight (Loong, 2013). Starting at the top of the level, supervision should be established. This will assist the administration in avoiding incorrect correspondence and task comprehension.

Miscommunication Due to a Language Barrier

The communication breakdown at the job site is exacerbated by the language barrier between immigrant labour and local management. According to Dai (2009), the most common difficulty that American site supervisors experience when dealing with international employees is language. When using Indonesian employees in Malaysian construction projects, the scenario is similar. More than 40% of construction site respondents, according to Razak (2016), we're concerned about misunderstanding (Augusto, 2020).

Cost

Should the task's inadequate expense be managed, a low-cost allocation in development endeavours would effectively decide the task's fate. Work has been the most difficult part to cost, according to Proverbs (2002), because it makes up such a small portion of the development cost. Workers for hire who have not budgeted adequately for the project will

reduce the overall cost of the project. As a result, the work required to complete a project is insufficient, and there will be development delays. Defective materials used to the structure and a powerless master dynamic, according to Paul (2013), can also justify why a structure is abandoned. In their analysis, Low (2014) believes that a better plan could address certain potential workmanship difficulties. Insufficiently worded information and imprecise plans, according to Rosli (2019), are further grounds for building absconds.

CONCEPTUAL FRAMEWORK ON QLASSIC TO REDUCE DEFECTS IN HIGH RISE RESIDENTIAL

Based on their professional experiences and their knowledge of the construction industry, respondents provided their suggestions on how this assessment may be improved. They felt that this assessment needed to have been improved in order to increase productivity and decrease defects in residential construction. The improvement criteria put forth by respondents during the interview are shown in Table 4. The criteria were broken down into management, supplies/equipment, and QLASSIC content. The framework for QLASSIC to lower defects in high-rise residential buildings is shown in Figure 1.

Table 4. Criteria of Improvement on QLASSIC

Improvement on QLASSIC	A	B	C	D	E	F	G	Total
MANAGEMENT								
Inspection on workmanship	1	1	1	1	0	1	0	5*
MATERIAL/EQUIPMENT								
Evaluation on material	2	0	2	1	1	1	2	9*
CONTENT								
Submission on design document	1	2	1	1	3	2	1	11*
Redo- rectification	0	1	0	0	1	1	2	5*

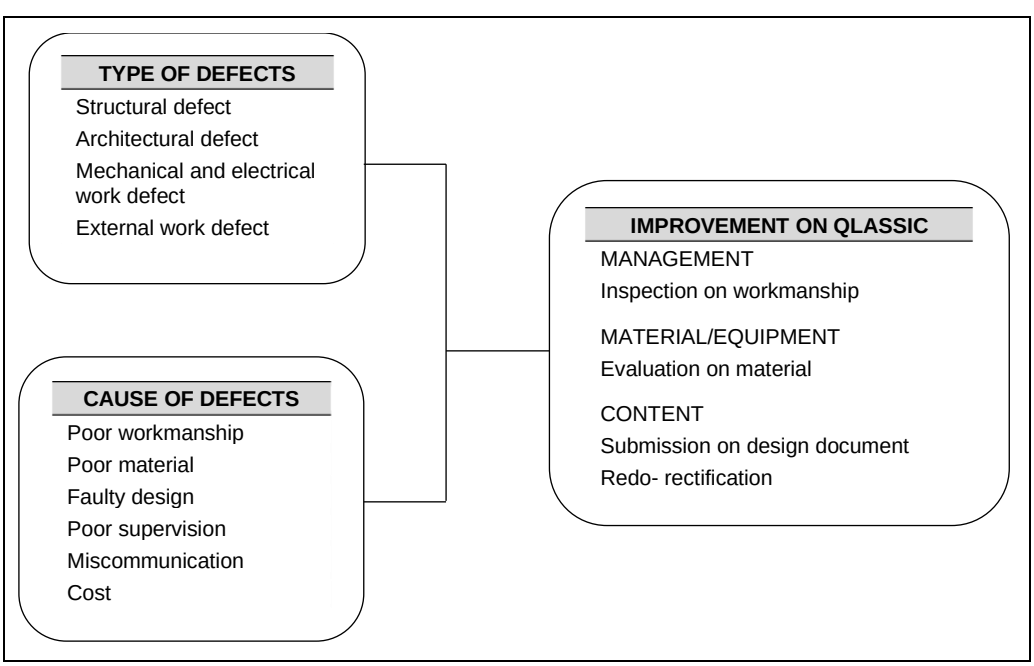

Figure 1. Framework on QLASSIC to Reduce Defects in High Rise Residential Project

Improvement on QLASSIC is stand from inspection on workmanship under management (14.29% 5 out of 35), evaluation on material under material/ equipment (25.71% 9 out of 35), submission on design document (31.43% 11 out of 35), and redo rectification under content of QLASSIC (14.29% 5 out of 35).

Management

Inspection on Workmanship

According to Azir (2018), management are requested to apply and implement various type of system to monitor performance level of workers. Currently, in technology-based industry have developed easy tracking system such as Gantt chart and Microsoft project and some paid system to trace working performance level without facing them directly. These technologies can be implemented to various type of industry. In construction industry Microsoft project used as a great tool to trace workers performance level. Based on the data analysis, can be conclude that, providing extra technology-based training and improvisation on training will increase the knowledge of assessors and quality of inspection will increase.

Material and Equipment

Evaluation on Material

The construction equipment's as concrete pumps, concrete mixers, vibrator, compactor are very important factors affecting the defects occurrence; the absence of these tools will lead to improper construction process, especially during concrete casting or soil backfilling. Apart from that, material is important part in construction. Quantity, quality and storage system is all important element is material handling system. When research back, most of the defects and building failure cases are occur due to poor material usage. Apart from that, evaluation on material is one of the improvements which suggested by respondents. Respondents believes that material and equipment are one of the most important part in develop a good quality project. Thus, evaluation on material and equipment have to be included in QLASSIC evaluation in scoring system. Evaluation on material and equipment may submit to QLASSIC assessors to carry out evaluation.

Content of QLASSIC

Submission on Design Document

Every component that will be employed during the construction phase is referred to as being in the design. In a project, there are mechanical and electrical drawings, architectural drawings, and structural drawings (Harun, 2015). Building a project using ideas requires a lot of design. It is essential for turning a design into a workable design. To ensure that a structure is designed properly and to last for many years, good designs take a lot of work. Errors made during the design phase, construction phase, maintenance practise, and material selection were the main causes of faults in a building. Design has demonstrated to be a key factor in defect maintenance (Ying, 2016).

Redo-Rectification Works

QLASSIC follows the "first time review" principle, which means that any building activity that is corrected as a result of an assessment is not re-assessed. This principle's goal is to motivate contractors to "Do It Right the First Time, Every Time." This is an ideology that I strongly support. However, these assessments should be more stringent in order to avoid major flaws and failures in residential projects. As a result, after the evaluation, assessors must produce a report indicating which works (structural, architectural, mechanical and electrical, or external work) or a specific work requires rectification or redoing to improve quality. The assessors will generate a QLASSIC score at the end of the report, which will be divided among all of the work. As a result, the lowest-scoring work had to be redone and inspected by assessors after correction. The assessor may not need to change the score after the rectification but should simply ensure that the correction was made to reduce the number of defects and increase the project's safety.

CONCLUSION

It is worth remembering that entire structures might develop defects, breakdowns, deterioration, and variances. A range of architectural flaws and the elements that contribute to them have been studied in the literature in relation to the main issue of this research. It is essential to assess each flaw and failure in every construction and identify their underlying causes. Make the necessary modifications following that. It is important to carefully investigate the factors that lead to these flaws and failures. It is crucial to identify solutions to prevent errors and failures in the future and lessen their effects after identifying the various causes of faults and failures. According to the results, it can be inferred that in order to prevent issues with high-rise constructions, workmanship, materials used, design, supervision, and communication.

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CURRENT STATE OF THE ART AND PRACTICE OF UNDERGROUND UTILITY DETECTION TECHNOLOGY

Kai Chen Goh[1], Xin Yee Low[1], Wan Fei Ngoh[2], Nadzirah Zainordin[3] and Hui Hwang Goh[4]
[1]Department of Construction Management, Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Malaysia.
[2]Director, Greenscapes Sdn Bhd, Petaling Jaya, Selangor Darul Ehsan, Malaysia.
[3]School of Architecture and Built Environment, Faculty of Engineering, Technology & Built Environment, UCSI University, Kuala Lumpur, Malaysia.
[4]School of Electrical Engineering, Guangxi University, Nanning, China.

Abstract
Underground utility is one of the essential elements for the growth of the economy of any region. As a result of rising urbanisation, demand for critical utility services, including electricity, water, and telecommunication, is increasing. As utilities are buried under the earth, maintaining and installing become more complex. There are numerous unsuccessful excavation accidents recorded annually all around the world. Damage impacts include project delays, financial losses, environmental pollution, and fatal and nonfatal injuries. Eventually, it showed how important to map underground utilities with existing practices and technologies. Therefore, this paper presents a comprehensive review of current practices in underground utility detection in Malaysia and worldwide are compared. It then focuses on underground utility detection technologies' state of the art, and their advantages and limitations are identified. Finally, the current state of the art and practice of underground utility detection technology have been identified.

Keywords: *Current; state of the art; practice; underground utility detection technology.*

INTRODUCTION

The underground utility is crucial for supplying electricity, gas, water, and other essential services to society (Fenais, Ariaratnam, Ayer, & Smilovsky, 2019; Wang, Deng, Won, & Cheng, 2019). Besides, the demand for these essential utility services is increasing dramatically according to the growth of the population. As utilities are buried under the earth, therefore, maintaining and installing are difficult (Cheng, Amerudin, & Yusof, 2019). According to Jaw & Mazlan (2013), every year, several unsuccessful excavation incidents are recorded around the world, resulting in power outages, hazardous pipeline explosions, and other major mishaps. In contrast, Singh & Mohamed (2020) highlighted that repairing damaged utilities can be exceedingly expensive and influence the expected profit of a construction project. The expenses of these damages are frequently high and rising. In 2019, the Damage Information Reporting Tools (DIRT) report estimated the annual societal costs of damages to buried utilities in the United State to be approximately USD 30 billion (DIRT, 2020). Numerous occurrences of unfavourable incidents caused by unsuccessful excavation as a result of poor utility pipeline mapping are documented each year (Jaw & Hashim, 2014).

In Malaysia, construction and land development sectors are rapidly developing, and therefore underground utility accidents are alarming and rising (Ezam & Mat, 2021). Consequently, the Malaysian Government spends around USD 12.9 billion each year to cover the cost of losses resulting from the failure of excavations for utility maintenance (Gani & Hamid, 2018). In Malaysia, underground utility mapping presents a completely new challenge for land surveyors in identifying underground utilities. The major requirement for

underground utility mapping is the industry involves the use of high-technology equipment, knowledge, and expertise (Jamil, Nomanbhoy, Yusoff, & Yusof, 2015).

One of the current practices to map underground buried utilities is Subsurface Utility Engineering (SUE) is an engineering technique that is created to address the issues caused by incorrect utility mapping and to establish the position or location of a natural or artificial structure above or beneath the earth's surface. SUE utilises new and old technology to precisely locate, classify, and map underground utilities with expert utility records research, geophysics, survey, site inspection, and utility exposure. To maintain the use of SUE, several care standards have been developed, including ASCE Standard 38-02, Malaysia Standard Guideline for Underground utility mapping, and British Standards Institute PAS 128. The concept of SUE is gaining traction around the world as a framework for mitigating costs associated with project redesign and construction delays, as well as avoiding risk and liability associated with damaged underground utilities.

There are numerous possible underground utility detection technologies such as ground penetrating radar, and electromagnetic locators that are frequently used. Thus, this paper reviews the current state of the art and practice of underground utility detection technology. The paper starts by exploring the current practice implemented in Malaysia and worldwide followed by a detailed description of the underground utility detection technologies. Following this, the advantages and limitations of each technology are discussed.

LITERATURE REVIEW

Current Practices of Underground Utility Detection

In general, local authorities in worldwide have incorporated practices to map the underground utilities better. There numerous practices have been implemented worldwide that have resulted in a sustained reduction in underground utility damage. These include comprehensive standards, and initiatives involving many different countries such as the One-Call Centre in the United States of America and Australia. As a result, different countries have adopted other best practices to ensure accurate underground utility maps and reduce underground utility damage during construction.

Practices in Malaysia

The Department of Survey and Mapping (JUPEM) in Malaysia is the only agency with the ability to oversee mapping and surveys of the nation's underground utilities. JUPEM developed the Standard Guideline for Underground Utility Mapping to provide utility industry stakeholders guidelines and techniques for gathering, combining, and presenting underground utility data. JUPEM states that each quality level, A through D, has a different set of requirements, with A being the most exact and D being the least accurate. Quality level A necessitated non-destructive excavation procedures to locate subterranean utilities accurately. Among the most current non-destructive testing methods are acoustic emission testing (AE), electromagnetic testing (ET), guided wave testing (GW), ground penetrating radar (GPR), laser testing methods (LM), leak testing (LT), magnetic flux leakage (MFL), microwave testing, and liquid penetrant testing (PT) (Akhter & Promei, 2018).

Moreover, two guidelines have been developed by JUPEM: the Guideline for Utility Surveying and Detection and Guideline for Surveying New utility Installation. Based on the Guideline for Utility Surveying and Detection, some techniques and practices are recommended to execute utility detection for quality levels A and B. The most common electromagnetic technique includes many methods: Ground Penetrating Radar (GPR), Pipe and Cable Locator (PCL), Metal Detectors, Terrain Conductivity, Resistivity Measurements, Infrared Thermal Methods, Resistivity Measurements, Optical Methods, and X-ray Methods. The technique is classified into Electromagnetic, Magnetic, and Elastic Waves. Besides, the Magnetic Method included Magnetometer with Total Field Measurements and Gradiometric Measurements. Besides that, guideline for Surveying New Utility Installation stipulates the various requirements and surveying procedures for surveyors to follow in installing new underground utilities.

Practices in United States

In United States, standards of practices have been developed to help stakeholders establish the data quality required for an underground utility locating survey. The Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data was created as a result by the American Society of Civil Engineers (ASCE) (ASCE 38-02). This standard is also essential for outlining the method for obtaining data on utility placement and characterisation and the reliability of such data when it is utilised on plans or quoted in other documents. The American Society of Civil Engineers stated that there are a total of four levels of quality for underground utility information, ranging from quality level (QL)-D, quality level (QL)-C, quality level (QL)-B, and quality level (QL)-A.

The Canada Standard Associate created the Mapping of Underground Utility Infrastructure (CSA S250) in Canada. The CSA S250 was developed to boost accuracy, dependability, and better record-keeping in identifying and mapping subsurface infrastructure. This standard defines the 3D mapping criteria for recording and displaying subterranean utility infrastructure, with five accuracy levels ranging from 0 to 5. Unlike other standards, the recent version contains new field locating and mapping technologies such as supplemental records, LIDAR, total station survey (TSS), and video capture were used. As a result, it is suggested that all stakeholders, including clients, utility owners, regulators, designers, and contractors, benefit from precise, timely information, and dependable drawings of underground utility infrastructure following CSA S250 and ASCE 38-02 standards.

According to Al-Bayati & Panzer (2019), One-Call Centre is a critical component of current damage prevention measures and the role of the One-Call Centre is vital to excavators and utility owners because of positive responses from the utilities. Recently, Al-Bayati & Panzer (2019) was surveyed to analyse the overall performance of the One-Call Centre. The results showed that the current notification process efficiently and effectively improves underground utility management. This initiative has been developed to ensure excavators dig carefully within a utility.

Furthermore, the Common Ground Alliance established the Damage Information Reporting Tools (DIRT), an online database that allows stakeholders in the industry to input information for damage prevention. According to Common Ground Alliance, the DIRT report is essential for understanding the most critical concerns facing damage prevention. Otherwise,

the DIRT report contained all data submitted by utility locating companies, One-Call Center, contractors, and others from the US and Canada. All data will be analysed in-depth and statistically.

Practices in Europe

To provide a consistent standard for the location of subsurface utilities, accurate, high-quality data had to be recorded. In the United Kingdom, there are numerous underground utility detection standards. One of the standards is PAS 128: Specification for Subsurface Utility Detection, Verification, and Localization. A partnership between Civil Engineers and the British Standards Institution resulted in the development of PAS 128. The PAS 128 closely followed other standards, which included four different quality levels: quality level A, quality level B, quality level C, and quality level A. In comparison to guidelines or standards in other countries, PAS 128 specifies that a minimum of two methods, Ground Penetrating Radar (GPR) and Electromagnetic Locators (EML), be utilised for quality level B geophysical surveys (Metje, Hojjati, Beck, & Rogers, 2020).

According to the Institution of Civil Engineers (ICE), one standard, PAS 256 was established for recording, capturing, managing, and distributing information about buried assets in the UK. Meanwhile, in response to limited industry standards, this standard was designed to increase the general quality, accuracy, and dependability of records across the industry. Furthermore, difficulties such as coordination of information challenges, which are costly and bureaucratic, can result in delays, rejected permits, and re-work, all of which will add to the expense and disruption. Hence, PAS 256 intends to increase the linkage of assets as part of the vital national infrastructure with projects such as smart cities and BIM.

According to Metje et al. (2020), MTU and the UK industry fought to establish an industry standard in the UK for underground utility surveys, resulting in the creation of a Publicly Available Specification (PAS) in the British Standards Institution. Besides MTU, there are numerous projects, like the National Underground Assets Group (NUAG), Association of Geotechnical and Geoenvironmental Specialists (AGS), and Accessing Subsurface Knowledge (ASK), attempting to overcome the issues of obtaining and sharing data related to subsurface features.

In France, the Declaration of Intention to Commence Work (DICT) was implemented as the national damage prevention system that requires all key underground network infrastructure locations to be accurately measured. Apart from that, the DICT is mandatory for all affected network operators to be informed of the works' start and duration. The Work Plan Declaration (DT) is important as the project owner must check that network operator related to the project are compatible with their infrastructure.

Practices in Australia

Standards Australia Committee IT-036 published the Classification of Subsurface Utility Information (AS 5488) in Australia. This standard was intended to give utility owners, excavators, and locators a way to categorise information regarding underground utilities in a consistent manner. This standard, like those in other nations, highlighted four quality levels: A, B, C, and D, based on the correctness of SUI. The requirements met with electromagnetic

frequency finding equipment were included in the quality level B. A DBYD Certified Locator providing an electronic location to the maximum horizontal tolerance would be 300mm while for maximum vertical would be 500mm according to QL-B standard. While quality level A is the maximum level of accuracy in the standard. Furthermore, this standard establishes a nationwide standard format for capturing subsurface utility data.

Like other countries, Australia also has a mechanism similar to Dial Before You Dig (DBYD), which works the same as One-Call Centre in the USA. The difference is that DBYD has a website where users can make requests online, which are then forwarded to utility companies through a single contact centre (Wu & Zhang, 2015). The DBYD is essential in sharing detailed plans and underground information provided by individuals and utility providers planning to dig underground. The DBYD is an important instrument to use in the Australian underground industry as the first stage in any safe excavation. It provides cost-effective services and saves utility owners and organisations participating in underground excavation.

Practices in Asia

The Singapore Land Authority (SLA) released the Standard and Specifications for Utility Surveying in Singapore. However, the standard does not detail the format or what should be done with the data as-built. This standard focuses only on survey accuracy for as-built surveys and should be followed according to horizontal accuracy (±100mm) and vertical accuracy (±100mm). The Global Navigation Satellite System (GNSS) generates high-quality data output that may be used to create 3D models with precise absolute and relative positioning. Laser Scanning Technology has recently emerged as the new industry standard in Singapore for exact three-dimensional (3D) measurements. Static terrestrial laser scanning and mobile laser scanning are the two types of laser scanning mentioned in this standard.

The Japanese Road Administration Information System (ROADIS) is a nationwide initiative to create a digital mapping system that would give road administrators and public utility sectors information about roads and utilities across networks throughout Japan. Gas, electricity, telephone, water, and sewage pipes are all crammed beneath modern city roadways. As a result, road administrators and utility providers may use terminals joined to databases at each of ROADIS's branch sites to obtain road maps and information on existing underground and above-ground facilities. This enables better planning, coordination, and the development and maintenance of public services inside the right of way.

In Hong Kong, Particular Specification for Utility Mapping by Non- Destructive Methods was introduced. This standard mainly covers non-destructive methods for identifying the location of subsurface utilities. Survey results are classified as low, medium, or high in terms of accuracy. At the recorded locations and intervals described above, the position and level of locatable services must be associated with grid control points and bench markings that are better than the 100 mm root mean square. Pipe Cable Locator (PCL) and ground-penetrating radar (GPR) are two typical electromagnetic techniques.

Table 1. Current Practices in Malaysia, United States, United Kingdom and Australia

	Standards & Initiatives
Malaysia	• Standards Guideline for Underground Utility Mapping • Guidelines for Utility Surveying and Detection • Guidelines for Surveying of New Utility Installation • Guidelines for Survey of New Underground Utility Corridor • Guidelines for Colour Code and Marking of Underground Utility Survey • Guidelines for Lodgement of Digital Data and Utility Survey Plans from LLS to DSMM
United States	• Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data (ASCE 38-02) • Standard Associate created the Mapping of Underground Utility Infrastructure (CSA S250) (Canada) • One-Call Centre • Damage Information Reporting Tool (DIRT)
Europe	• Specification for Underground Utility Detection, Verification, and Location (PAS 128) (UK) • Buried services -Collection, recording, and sharing of location information data (PAS 256) (UK) • Mapping the Underworld (MTU) (UK) • National Underground Assets Register (NUAR) (UK) • Association of Geotechnical and Geoenvironmental Specialists (AGS) (UK) • Accessing Subsurface Knowledge (ASK) (UK) • Declaration of Intention to Commence Work (DICT) (France)
Australia	• Classification of Subsurface Utility Information (SUI) (AS 5488) • Dial Before You Dig (DBYD)
Asia	• Standard and Specifications for Utility Survey (Singapore) • Japan Road Administration Information System (ROADIS) (Japan) • Particular Specification for Utility Mapping by Non- Destructive Methods (Hong Kong)

Underground Utility Detection Technologies

Nowadays, there are various technologies are used for underground utility detection. Based on a report prepared by Dolatabad, Doree, Olde Scholtenhuis, & Vahdatikhaki (2017) these technologies have been classified into two categories: local pull detection and local push detection. Besides, it is also classified as direct and indirect methods. According to Ge et al. (2021), electromagnetic induction technologies, electromagnetic wave technologies, acoustic technologies, other physics-based technologies, and emerging technologies are the categories in which these technologies are classified.

Ground Penetrating Radar (GPR)

GPR is a mature geophysical technique that provides high resolution (Campos, Vidal-Torrado & Modolo, 2019; Sagnard et al., 2016). Otherwise, GPR is useful for detecting metallic and non-metallic things (Liu et al., 2020). This method is widely adopted because of its convenience and high speed. GPR performance is incredibly reliant on soil type and site circumstances. For example, as mentioned earlier, GPR works well on sandy soils but is restricted to wet soil, clay, water, and organic matter environments. Besides, the frequency of the antenna used in GPR is crucial. Compared to other technologies, GPR can estimate the larger or smaller depths with minor inaccuracy depending on the frequency of an antenna. Other drawbacks of GPR include the high cost of the surveying procedure, the need for skilled operators, shallow buried cables are ineffective detection, and the limitation of small diameters (Ge et al., 2021; Li, Wu, Xie, & Dai, 2019; Liu, Serhir, & Lambert, 2018). At last,

it has been proved that GPR is still a dependable technology, no matter in terms of maturity, technical characteristics, and other aspects.

Electromagnetic Locator

In passive mode, only a receiver device is required and it is usually suitable for the case of activated and loaded power lines where there is enough current to detect power frequency harmonics. Very low frequency for this mode from a distant transmitter, for example, power lines which can generate a radio frequency from underground metallic utilities that can also be detected passively. This technique is often used for unrecorded cables rather than tracing utilities. The most frequent approach of the electromagnetic method is electromagnetic induction (EMI), which works well in electrically conductive areas. According to Sadatcharam, Altdorff, Unc, Krishnapillai, & Galagedara (2020), EMI is a quick and cost-effective technique to provide important information from relatively large-scale regions on shallow soil and can even be employed in locations with limited accessibility.

On the other hand, multi-frequency (MF) and multi-coil (MC) sensors are the most common types of sensors. The performance of the MF sensor is more affected by temporally changing soil properties, mainly in soil water content. In contrast, the MC sensor is less influenced by changing weather conditions (Siu & Lai, 2019). As a result, the usage of EMI sensors enables faster survey than other conventional devices (Martini et al., 2017).

Magnetometer

A magnetometer is an essential instrument that detects changes in the magnetic field of the earth (Sirisuraphong, Duangnet, & U-Tapao, 2020). According to a prior study, the magnetometer survey is the best technology used in the industry, and the depth recorded as a possible inaccuracy of only 8% (Vo, Staples, Cowell, Varcoe, & Freear, 2020). On the other hand, the magnetometer is only applicable for materials that contain iron or ferrous, and its accuracy can be influenced by neighbouring objects (Liu et al., 2020; Sirisuraphong et al., 2020). Fluxgate magnetometers are extensively used in geophysical and solar system studies to detect magnetic fields in situ (Narita, Plaschke, Magnes, Fischer, & Schmid, 2021). While proton precession magnetometers measure the changing magnetic field, are the most often used total field magnetometer (Liu et al., 2020). According to Tan, Wang, & Li (2019), the precision of the low signal-to-noise ratio (SNR) Larmor frequency output from sensors is determined by the measurement precision of proton magnetometers (PM).

Gradiometer

Gradiometers have been studied for detecting buried items by combining two magnetometers vertically separated by a set distance (Turner, Stine, & Stine, 2018). The gradiometer's benefits include ease of use, high accuracy, strong anti-interference, high stability, and a vertical component, a magnetic gradient detector (Liu, Dong, Ge, Bai, & Zhang, 2017). Apart from that, the gradiometer enables a quick evaluation of what characteristics may be present on a site, as well as determining where further surveys with other devices should be conducted (Turner et al., 2018). Gradiometers can detect near-ground objects at greater distances than metal detectors, but they require many full-field sensors, making them costly.

Acoustic

Acoustic approaches work well in various soil types but are limited to high conductive soils, unlike other technologies (Liu et al., 2020). In terms of material, it is the ideal technique for many materials such as metallic, non-metallic, and plastic. Researchers believed that one of the most successful detecting technologies is vibro acoustic locating (Liu, Habibi, Chai, Wang & Chen, 2019). Although the vibro acoustic approach is the most reliable, it is recommended to use traditional methods for improved detection. However, the acoustic approach is not suggested for detecting the depth of buried utility, because of sensitivity to environmental conditions (Adegboye, Fung, & Karnik, 2019). The main benefits of acoustic techniques are their effectiveness for various soil types and their identification of non-metallic objects (Liu et al., 2020). According to researchers, depending on the soil type, the frequency range of 50 Hz to 150 Hz proved most effective. This technique is simple, with early detection, portability, and cost-effectiveness (Adegboye et al., 2019). However, several disadvantages include the inability to predict burial depth and sensitivity to random and ambient noise.

Radio-Frequency Identification (RFID)

Radio-frequency identification (RFID) is the technique for monitoring and detecting underground utilities. An electronic tag can be affixed to or wrapped around it to store information about an object. Between the reader and the tag, data is transferred and received through radio waves. The low-cost, passive, and wireless monitoring and detecting sensors market is rapidly growing (Zarifi, Deif, & Daneshmand, 2017). In contrast, RFID can provide precise and immediate access to underground utility data without requiring repeated excavations (Ji et al., 2018). Apart from that, the tags are easily destroyed, the service life of electronic tags is short, and the signal return distance is relatively short (Ge et al., 2021). Besides, the tag is costly and ineffective for providing complete coverage over lengthy pipelines (Deif & Daneshmand, 2020). According to a previous study, RFID has some advantages, and the most important is that it may enable exact and rapid access to subsurface utility data. Many researchers are now exploring and investigating RFID to monitor the integrity of underground infrastructure. For example, Derif & Daneshmand (2020) proposed an integrated chip-less RFID system for pipeline integrity monitoring. However, RFID is not suggested for long-distance infrastructure since it is too expensive.

Fibre Optic Sensor

There are various types of optical fibre sensors have been commercialised. Two kinds of fibre optic sensors are based on their sensing technology: distributed sensing and multipoint localised sensing. They can detect a few physical qualities such as magnetic, electric fields, colour, radiation, vibration, pressure, position, strain, and chemical changes. Recently, there are many researchers have investigated fibre optic sensors, primarily distributed optical fibre sensing techniques for subsurface utility monitoring. The benefits of using fibre optic sensors include small in size, resilience to radio frequency interference (RFI), and electromagnetic interference (EMI) (Gulmohammed & Singh, 2018). Fibre optic technology allows for high-precision dispersed temperature measurement as well as high-sensitivity spread vibration (Li, Wu, Xie, & Dai, 2019). A distributed optical fibre sensor, for example, provides the advantages of extended sensing distance, temperature measurement, continuous and dispersed measurement, and high reaction speed (Ren et al., 2018; Wang et al., 2021). The best point is

using distributed sensors is that they are connected to fibre optic cables and suitable for long-distance transmission. The main drawback of fibre optic technology is the cost of implementation is high and not durable (Adegboye et al., 2019).

Table 2. Summary of Underground Utility Detection Technologies

Technologies	Advantages	Disadvantages	Sources
Ground Penetration Radar (GPR)	• Provides high resolution • Helps detect metallic and non-metallic material • Easy to use and high speed • GPR works well in sandy soils • Slightly inaccurate depth estimation • Reliable technology in terms of maturity, and technical characteristics	• Exploratory procedures are costly and time consuming • Requires skilled operator • Does not affect flat laid cables • Restricted to environments containing moist soil, clay, water, and organic matter	(Campos et al., 2019; Ge et al., 2021; Liu et al., 2018; Liu et al., 2019; Sagnard et al., 2016)
Electromagnetic Locator	• Fast and cheap technology. • It can be used in restricted access areas • Enables faster acquisition than other devices	• It can only be used to detect metal utilities • Sensitive to changing soil properties over time, especially changes in soil moisture content • Site-specific and dependent soil conditions	(Martini et al., 2017; Sadatcharam et al., 2020; Siu & Lai, 2019)
Magnetometer	• Best technology used in the industry • Possible to accurately determine the depth of buried objects	• Applies only to ferrous materials where accuracy may be affected by nearby objects	(Liu et al., 2020; Narita, Plaschke, Magnes, Fischer & Schmid, 2021; Sirisuraphong et al., 2020; Vo, Staples, Cowell, Varcoe & Freear, 2020)
Gradiometers	• Ease of use • High accuracy • Strong anti-interference • High stability, and a vertical component • Can quickly assess the features that may exist on site	• It can detect objects on the ground than metal detectors but is expensive because it requires many full-field sensors	(Liu et al., 2017; Turner et al., 2018)
Acoustic	• Effectiveness on various soil types • Excellent on many materials, including metals, non-metals, and plastics • Easy for early detection, portability, and cost effectiveness	• Unable to estimate depth • Sensitive to both random and ambient noise • Limited to highly conductive soils	(Adegboye et al., 2019; Liu et al., 2019; Liu et al., 2020)
Radio-frequency identification (RFID)	• Completely battery free • Inexpensive real-time integrity monitoring • Can be driven into a pipe structure • Accurate and instant access to underground utility information	• Electronic tags are easily destroyed and temporary spam • Signal return distance is relatively short	(Deif & Daneshmand, 2018; Ge et al., 2021; Ji et al., 2018; Zarifi et al., 2017)
Fibre Optic Sensor	• Small in size • Immunity to radio frequency interference (RFI) and electromagnetic interference (EMI) • Enables highly accurate distrusted temperature measurement • High sensitive spread vibration	• High installation cost and not permanent	(Adegboye et al., 2019; Li et al., 2019; Ren et al., 2018; Wang et al., 2021; Gulmohammed & Singh, 2018)

CONCLUSION

This paper reviews the literature related to current practices in Malaysia, United States, Europe, Australia, and Asia. And it found that numerous practices in these countries have been widely established. Most countries have standards and guidelines for underground utility practices published. For example, One-Call Centre's have been commonly used in several countries such as United States and Australia during excavation. Besides that, state-of-the-art underground utility detection technologies are also discussed and summarized based on their advantages and disadvantages. Currently, no technology can have absolute advantages. Therefore, current underground utility detection technologies must be improved and transformed with new technology.

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COMMUNITY PERSPECTIVE IN CONSERVATION OF LIVING HERITAGE

Intan Syafinar Jamaludin[1,3], Seow Ta Wee[1,3] and Indera Syahrul Mat Radzuan[2,3]
[1]Department of Construction Management, Faculty of Technology Management & Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Johor, Malaysia.
[2]Department of Real Estate, Faculty of Technology Management & Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Johor, Malaysia.
[3]Center of Sustainable Infrastructure & Environmental Management (CSIEM), Faculty of Technology Management & Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor, Malaysia.

Abstract
Living heritage is characterised by the concept of "continuity and identity" of a core community due to its special cultural heritage that resides in a specific heritage site. Nowadays, living heritage encountered risks of losing its cultural heritage due to rapid urbanization, deterioration, and destruction of heritage sites, growing tourism, and natural disasters. One of Melaka's key shocks and stresses listed under its 100 Resilient Cities programme is the risk of losing World Heritage Status and its intangible heritage. Conducive to achieving a sustainable community, it is essential to conserve the living heritage of the Portuguese community by understanding their perception of the conservation of community cultural heritage. Hence, the objective of this paper is to analyse community understanding and perception towards safeguarding community cultural heritage. This is done by using a quantitative survey. A total of 238 responses were received and analysed using SPSS version 26.0. The result reveals the conservation of a people-centered approach to the conservation of cultural heritage driven by elements such as public participation, awareness, communication, education, capacity building, heritage incentives, and stakeholders' involvement. The findings of the paper would be beneficial to stakeholders, practitioners, and researchers to build a sustainable community within the heritage site while preserving its heritage value.

Keywords: *Living heritage; people-centered approaches; community cultural heritage; Melaka*.

INTRODUCTION

Living heritage sites are currently struggling with modernization, globalization, and authenticity issues, which have caused the community living in heritage sites to gradually lose their practices and traditions. World Heritage Sites (WHS) are cultural and or natural sites considered to be of 'Outstanding Universal Value", which are inscribed under The United Nations Educational, Scientific, and Cultural Organization (UNESCO). UNESCO objectives to promote the recognition, restoration, and conservation of cultural heritage and natural resources around the world (UNESCO, 1972.). The International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM) established a Living Historic Sites Programme in 2003 to safeguard the heritage community. The program's aim was to increase awareness of living heritage perceptions in the context of managing heritage sites and conserving cultural heritage (ICCROM, 2005). In this sense, living heritage is connected with communities and the continuity of practises and traditions.

Conservation of living heritage The International Council on Monuments and Sites (ICOMOS) established a resolution that People-Centred Approaches to Cultural Heritage, a follow-up to ICCROM's Living Heritage Site Programme. The goal of the resolution was to encourage the development of local, national, and international heritage policies and practises

that take into account the different environmental, cultural, and socioeconomic concerns of individuals and communities (ICCROM, 2015).

The state of Melaka was selected to join the 100 Resilient Cities (100RC) Global Network in 2016. The 100RC programme is dedicated to helping cities become more resilient to physical, social, and economic challenges. Melaka, as one of the WHS sites, has become a domestic and international tourist node, undergoing rapid urban development to accommodate and attract tourists. The radical transformation makes Melaka vulnerable to floods, water shortages, disease outbreaks, fire hazards, and the risk of losing world heritage status (MBMB & 100RC, 2019).

The living heritage site of Portuguese Settlement has been affected the most by rapid urbanisation, as right in front of their settlement, massive reclamation work has occurred. The community expressed concerns and dissatisfaction since the reclamation work was carried out without conducting an adequate Environmental Impact Assessment (EIA) and without consulting the community (Ong, 2017). Conservation of core community living in a heritage site is a people-led approach where community involvement is enhanced by enhancing the community's capacity to consciously engage in the process of making conservation and management decisions for themselves and their heritage, and to take part in their implementation process. This paper aims to analyse the Portuguese community's understanding and perception of safeguarding a community's cultural heritage.

LITERATURE REVIEW

Living Heritage

The notion of living heritage is characterised by continuity, especially those historical places that are still a living part of their community (Wijesuriya, 2015). In the framework of the historical area, a living heritage site is a traditional community with a distinct neighbourhood. In this traditional settlement, the outstanding universal values are decided by the indigenous people and the physical attributes that maintain the skills, other cultural activities, and living traditions. These values have been passed down through generations.

A living heritage site is a site that re-creates historical settings in order to reproduce the past and present visitors with an immersive picture of history. It is a site that recreates the conditions of a certain society, historical era, or natural environment. Conceptually, it is a site with specified borders and a stable local community. Therefore, the community residing inside the living heritage varies from the surrounding community due to its unique relationship with the site and its continued development. The community considers the site their home as this provides them with a sense of belonging, comfort, and purpose in life. (Poulios, 2014).

The elements of the living heritage continuity approach may be categorised into three groups: cultural expression (both intangible and tangible), community connections, and continuity of care through traditional or established mechanisms (Poulious, 2014). The Living Heritage approach is an expansion of the two present approaches, notably value-based and fabric-based, and may be applied to any category of heritage (Wijesuriya, 2015).

In order for the heritage community to adapt to the changing world, it must change while keeping its original heritage functions. It supports community identity through people-centered approaches by constantly recreating cultural traditions that are supported by the environment.

People-Centered Approaches

Cultural heritage has been created by people and was created for people. When cultural heritage sites are viewed as integral part of communities, community participation typically helps both the heritage and the community. Communities include capacities and assets that exceed constitutional or specialist structures and complement professional knowledge and skills. A people-centered approach utilizes these capacities to provide long-term conservation and shared management for the benefit of the heritage and the good of the community (Court & Wijesuriya, 2015). Communities' participation in conservation and management processes is deemed as key factor within people-centred approaches (Wijesuriya, Thompson, and Court, 2016).

People-centered approaches response to contemporary issues in conservation. This approach will address the fundamental element of heritage management, connecting the community with heritage and certifying that it is a fundamental element in conserving that heritage (ICCROM, 2015).

Elements in Conservation of Community's Cultural Heritage

The necessity to conserve living heritage's cultural heritage is imperative as conservation elements are the basis for preserving the community's cultural heritage. The key to conserving living heritage cultural heritage is engagement through a people-based approach. Comprehensive engagement is to safeguard community members and shareholders. On the same note, it is also for assessment and management decisions, and also impacts and opportunities for the community.

From previous research and studies, six elements were identified to conserve community cultural heritage, including community participation, awareness, education, communication, capacity building, and stakeholder involvement. Active community engagement and involvement of the core community across all phases of planning, implementation, and development would foster a sustainable community for that particular cultural site. (Court & Wijesuriya, 2015; Poulios, 2014). Therefore, the community will be able to safeguard their cultural heritage by voicing out their concerns about cultural heritage-related issues.

The element of awareness is a critical focus for educating the public on the critical importance of acquiring cultural heritage knowledge. The conservation of cultural heritage through festivals, celebrations, education, heritage trails, and walks can raise public awareness (Jokilehto, 2017). In recent decades, it has been widely acknowledged that public education for heritage conservation through early education and ICT has the potential to increase access to and appreciation of cultural variety (Jokilehto, 2006; Thornton, 2008). Hunter (1988) contends that the most effective method for incorporating heritage education into a curriculum is to infuse one integration with current curricular materials in which all curricula disciplines serve as the foundation for heritage education. As a result, heritage

education increases people's awareness and understanding of the values, subjects, and events that permeate their cultural heritage (Hunter, 1992).

Meanwhile, multidisciplinary collaboration requires communication and engagement from the community and stakeholders in order to identify the specialised knowledge and skills required to address particular conservation concerns. Conservation initiatives require stakeholders to equal top-down and bottom-up strategies (Erlewein, 2017), encouraging communication among and within communities in accordance with their needs and concerns. In heritage conservation programmes, capacity building would involve practitioners and heritage organisations sharing their experiences and knowledge from others in order to enhance training by preparing them with the knowledge and instruments to work better and effective with communities throughout the existing management systems (Court & Wijesuriya, 2015). In the same way, it is important for the preservation of legacy assets that all stakeholders (cultural, social, economic, and environmental), as well as the public and community members, are involved in the process.

RESEARCH METHODOLOGY

A quantitative research methodology has been executed to analyse the level of community perception in safeguarding community cultural heritage in particular among the Portuguese community. The methodology of fieldwork is survey questionnaires, whilst analysis is conducted using the Statistical Package of Social Science (SPSS). The study relies on descriptive analysis to explain related issues in the study.

The survey questionnaire was divided into eight sections. Section (A) highlights respondents' profile characteristics; starting with gender, age, and education levels were remarked. The following sections highlight elements to conserve community cultural heritage and community understanding and perception in safeguarding community cultural heritage. Section (B) evaluates community participation in safeguarding their cultural heritage; Section (C) assesses community awareness in promoting the safeguarding of cultural heritage; Section (D) understands education's role in safeguarding the community's cultural heritage; Section (E) evaluates good communication practise to convey information in safeguarding cultural heritage; Section (F) assesses the need for capacity building to safeguard cultural heritage; and lastly, Section (G) evaluates stakeholders' involvement in safeguarding cultural heritage. The survey questionnaire was designed with three types of 5-point Likert scale, ranging from very important to not important; excellent to very poor; and strongly agree to strongly disagree.

A pilot study has been conducted beforehand to verify that the questions in the questionnaire forms (i) are understandable to the community of interest, (ii) are interpreted consistently by researcher and respondents, and (iii) obtain reliable and valid data. In this case, respondents from the Portuguese community and the community management council representatives were selected to test the validity of the research questionnaire. During real data collection, from 1100 sample size, 285 respondents were required (Krejcie & Morgan, 1970).

Study Area

The Portuguese community in Melaka is the result of interethnic marriages between Portuguese and local communities, which formed a hybrid ethnic group known as Portuguese Eurasians or Kristang. Figure 1 shows the location they lived in an area located near Ujong Pasir Melaka, which was once known as St. John's Village until the British renamed it the "Portuguese Settlement". In this 11-hectare settlement, there are around 200 households and 1100 people (D. Marina, personal communication, April 6, 2021).

Figure 1. Location of Portuguese Settlement

FINDINGS AND DISCUSSION

The pilot study conducted received many suggestions in terms of too many questions, the need to rephrase some questions, simplify the sentences, shorten the questions, and add more questions on community engagement. The reliability analysis was carried out in order to investigate the internal consistency of the scales used in this study. The results were satisfying, with Cronbach's coefficient alpha value ranging from 0.779 to 0.946. The actual data were collected from May 2021 to September 2021, which took a long time due to the country's Movement Restriction Order (MCO) imposed in response to the COVID-19 pandemic. From distributed questionnaires, 238 were valid with a return rate of 83%, while 53 questionnaires were nonresponse mainly due to missing answers. The data and response rate are summarised in Table 1.

Table 1. Response Rate

Population	Sample size	Questionnaire Returned	Questionnaire Nonresponse	Return Rate
1100	285	238	53	83%

Demographic profiles as demonstrated in Table 2 show that more than half of the respondents are females (n = 126, 52.9%), while males are represented (n = 112, 47.1%) of the sample. Regarding the age category of respondents, the majority of the respondents are aged from "21–30 years old" in the sample (n = 55, 23.1%), followed by the age range "41–50 years old" at a rate of (n = 44, 18.5%), and the least proportion reported (n = 6, 2.5%) with the age range "above 71 years old". By studying the education background, it was shown that

the majority of respondents with a secondary background (n = 135, 56.7%), and only (n = 27, 11.3%) of respondents with a university background.

Table 2. Demographic Profiles

		Frequency	Percentage
Gender	Male	112	47.1
	Female	126	52.9
	Total	*238*	*100%*
Age	Below 20 years old	26	10.9
	21 – 30 years old	55	23.1
	31 – 40 years old	40	16.8
	41 – 50 years old	44	18.5
	51 – 60 years old	43	18.1
	61 – 70 years old	24	10.1
	Above 71 years old	6	2.5
	Total	*238*	*100%*
Education level	University	27	11.3
	Collage	44	18.5
	Secondary	135	56.7
	Primary	13	5.5
	No formal education	12	5.0
	Others	7	2.9
	Total	*238*	*100%*

A descriptive analysis of the study elements has been conducted and summarised in Table 3. Overall, the analysis and discussion conducted in this paper found that the community's perception of elements for safeguarding community cultural heritage was moderately high. The conservation elements of the community's cultural heritage being measured were community perception, awareness, education, communication, capacity building, heritage incentives, and stakeholders' involvement. Based on these seven elements, the elements of community perception and communication were prominent, with a high average mean value of 4.37. These results suggest that most communities know the importance of knowing the value of their own cultural heritage and take part in any heritage programme. Through public participation, the community is able to convey heritage-related issues and challenges faced. Additionally, the community agreed on the importance of promoting, improving, and increasing heritage-related activities and the need for education on cultural heritage. Shimray (2019) further explained that local communities play an important role in restoring and sustaining the heritage site. Their involvement in heritage management helps them prosper economically and increases their overall quality of life.

The element of education in conserving community cultural heritage indicated a moderate average mean value of 3.91. The statement "School education programme on cultural heritage is enough" with the lowest mean value of 3.16 is due to the community being unaware of what is being taught in school nowadays and youngsters not being interested in learning about history. This finding is supported by a study by Tuncer (2017), who contends that heritage values are being eroded as a result of a lack of social awareness for the preservation of the historical and cultural environment, the acceleration of urbanization, and a lack of education.

Table 3. Descriptive Analysis of Elements

No	Statement	Mean	Std. Deviation
B	Community perception		
B1	Know the value in conserving tangible cultural heritage.	4.43	0.590
B2	Know the value in conserving intangible cultural heritage.	4.41	0.680
B3	Community to participate in cultural heritage programme.	4.44	0.597
B4	Community to participate in any planning and development in this settlement.	4.37	0.685
B5	Public participation able to communicate on issues and challenges faced.	4.20	0.711
	Overall	*4.37*	*0.653*
C	Awareness of safeguarding cultural heritage		
C1	Programme to promote the preservation of cultural heritage.	4.45	0.563
C2	Refresh cultural heritage meaning for self/community identity.	4.39	0.576
C3	Awareness of education about cultural heritage.	4.45	0.562
C4	Enhance the variety of activities related to heritage.	4.28	0.649
C5	Improve the frequency of cultural heritage awareness programme.	4.29	0.586
	Overall	*4.37*	*0.587*
D	Education on safeguarding cultural heritage		
D1	Educate the public on the importance of cultural heritage.	4.26	0.564
D2	School education programme on cultural heritage is enough.	3.16	1.346
D3	Right medium to educate people in creating heritage awareness.	4.31	0.611
	Overall	*3.91*	*0.840*
E	Communication		
E1	Community to voice out issues and challenges faced.	4.46	0.585
E2	Effective communication between community and government agencies is able to safeguard cultural heritage.	4.36	0.632
E3	The right medium will transfer the right information on heritage value.	4.39	0.591
E4	Knowledge-sharing sessions from heritage agencies will increase awareness among the community.	4.16	0.630
	Overall	*4.34*	*0.610*
F	Capacity building for the community		
F1	Heritage agencies provide training for the community regarding safeguarding cultural heritage.	4.13	0.655
F2	Training in heritage management will increase the value of a 'sense of protection' among the community.	4.20	0.608
F3	Training will increase the community's awareness and value of heritage.	4.17	0.578
F4	Do you have the knowledge to safeguard tangible heritage?	3.44	0.982
F5	Do you have the knowledge to safeguard intangible heritage?	3.39	1.021
	Overall	*3.87*	*0.769*
G	Stakeholders' involvement		
G1	Adopt local communities' views on their heritage planning approach.	4.26	0.654
G2	Cooperation between heritage authorities and the local community will safeguard the community's cultural heritage.	4.16	0.627
G3	Safeguarding of cultural heritage efforts leads by the government agencies.	2.91	1.051
G4	Cooperation between heritage agencies and the local community in safeguarding community cultural heritage.	2.84	1.051
	Overall	*3.54*	*0.846*

Communication is essential for identifying the specific set of knowledge and skills required to address particular conservation and preservation concerns. The average mean value for communication was moderately high at 4.34. The community was aware of the importance of good communication, able to convey the right information on heritage values and bridge the gap between community and heritage agencies in order to solve rising issues. Communicating directly with stakeholders and considering heritage values can support the community in providing information regarding their concerns and historical knowledge (Erlewein, 2017).

In order to conserve the community's cultural heritage, the community needs to be equipped with the right knowledge and capacity, and guidance from good practitioners. The element of capacity building has a moderate average mean value of 3.87. From the statement, the community has insufficient guidance and knowledge to safeguard their own tangible and intangible cultural heritage. The finding further supports the notion that the community is often disadvantaged by the lack of information on heritage conservation (Tosun, 2000).

Meanwhile, the element of stakeholders' involvement showed a moderate average mean value of 3.54. The statements scored lower mean values, indicated that the community's opinion on conservation of community cultural heritage efforts led by the government and cooperation between heritage agencies and the community were poor. The community was unaware of the efforts being made to the settlement and the conservation at the settlement was done among them. According to a study by Rahimah et al. (2015), the Portuguese community established their own museum to document and showcase their legacy.

The communities of Portuguese are facing the danger of losing their cultural heritage due to modernisation, globalisation, the migration of communities for competent lifestyles and working experience, and lacking heritage inheritance practice. Conservation of living heritage focuses on people-centred approaches, where engagement with communities in the conservation process is a vital component. As such, the survey was done to understand communities' perceptions and understanding of conservation community cultural heritage.

Statements involved in the survey are interrelated with other elements. In the element of community participation, communication, and stakeholder involvement played an important role in relaying cultural heritage concerns faced by the communities to the right heritage organization. This is supported by Spiridon & Sandu (2015), who stated that the involvement of stakeholders is the guiding principle of conservation by collaboration and participatory, which focuses on stimulating all stakeholders engaged in the process (cultural, social, economic, and environmental), while the active participation of the public and community members is essential for the protection of heritage assets. Therefore, they will be able to protect their cultural heritage by expressing their concerns about cultural heritage-related problems (Marchalek, 2008; Sapu, 2003).

Furthermore, from the above statements, the element of awareness has a close relationship with elements of education, capacity building, and communication. Through his research, Erlewein (2017) stated that direct communication and collaboration between stakeholders and communities are able to provide the values and heritage information needed for the conservation of community cultural heritage, as well as provide training to the communities by sharing their expertise in conserving cultural heritage. He also mentioned good

communication between community and heritage agencies with excellent communication mediums such as ICT and education, able to transfer the right information and conserve its heritage values.

Overall, a successful endeavour to safeguard cultural assets involves effective cooperation that encourages communication and engagement between the local community and heritage stakeholders. Community participative demonstrates the rights to access and participate in cultural life integrated with other individual rights such as access to education and awareness, freedom of speech, and self-mobilization. As a result, it offers a significant method of safeguarding and enhancing the physical, economic, and social aspects of the traditional settlement.

CONCLUSION

Living heritage is being jeopardised by losing its cultural heritage due to rapid urban development, globalization, modernization, lack of cultural heritage inheritance mechanisms, and a decrease in community size, mainly because young people are moving out for better work benefits and experiences. In the context of the Portuguese community who lived in Melaka WHS, they faced these issues. The conservation of living heritage is characterised by the continuity of tangible and intangible heritage, connections between communities, and continuity support of heritage mechanisms. But in the case of the Portuguese community, the people-centred approach has replaced the living heritage approach due to its contemporary issues in the conservation of community cultural heritage. The fundamental aspect of a people-centred approach is community participation in conservation and management processes. Six elements were identified to achieve the conservation of Portuguese community cultural heritage, such as community participation, awareness, education, communication, capacity building, and stakeholders' involvement. As the study shows, the Portuguese community has a good understanding and perception of how to safeguard and conserve their cultural heritage. With better understanding of the elements, it could ensure continuity of community cultural heritage.

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ENHANCING LEADERSHIP BEHAVIOUR TO IMPROVE EMPLOYEE MOTIVATION DURING THE COVID-19 PANDEMIC

Ainul Nabeel Fikri Ainul Zuhairi[1], Mohd Ashraf Mohd Fateh[2] and W.T Hong[3]
[1]Centre of Postgraduate Studies, Faculty of Architecture, Planning and Surveying Universiti Teknologi Mara, Shah Alam, Selangor, Malaysia.
[2]Centre of Studies for Construction, Faculty of Architecture, Planning & Surveying, Universiti Teknologi Mara, Shah Alam, Selangor, Malaysia.
[3]Centre of Excellence in Sustainable Building Design, School of Energy, Geo-science, Infrastructure and Society, Heriot-Watt University – Malaysia Campus, Putrajaya, Malaysia.

Abstract
The novel coronavirus disease 2019 (COVID-19) pandemic has affected employees across Malaysia to work remotely and in isolation. This crisis has particularly affected employee motivation, which is an important factor in maintaining work performance. The objectives of this study were to investigate the level of employee motivation in the remote working environment in the construction industry during the pandemic crisis, identify the effects of task-oriented and relation-oriented leadership behaviour in motivating employees during the pandemic crisis and determine the moderating role of digital readiness for the relationship between leadership behaviour and employee motivation. A questionnaire survey to 185 respondents was utilised in the data collection exercise. Various statistical analyses were done by using the statistical package for the social sciences (SPSS) software. The findings indicated that task-oriented and relation-oriented leadership behaviour was acquired to maintain employee motivation in a remote working environment during crises. Furthermore, the study confirmed that relation-oriented leadership behaviour influenced employee motivation more than task-oriented behaviour. The employee digital readiness was found to have an insignificant moderating effect between leadership behaviour and employee motivation. The study would contribute to the body of knowledge as there is limited literature on leadership and virtual work regarding leadership behaviour effectiveness and its impact on employee motivation during a pandemic.

Keyword: *Employee motivation; leadership behaviour; digital readiness; sustainable development goals No.3/8/9.*

INTRODUCTION

Coronavirus disease 2019 (COVID-19), is a novel pneumonia disease which originated in Wuhan, China and was confirmed by the World Health Organisation on 12 January 2020, before it became an outbreak throughout the world, as reported by (Shah et al., 2020). It had triggered the Malaysian Government to enforce a movement control order (MCO) starting on 18 March 2020, to break the COVID-19 chain. As a result, most employees had no choice but to work remotely from their organisation. It is also known as work from home (WFH) practice, which is through digital platforms, such as email, video conference, text messaging, and telephone calls. Ever since the first MCO was enforced, this remote working practice had become a new norm. In the construction industry, construction workers are not involved in the remote working environment as they need to be physically on-site to work. However, they still need to communicate with other construction players, including but not limited to clients, consultants, project managers, and authorities, which they were discouraged to meet face-to-face during this pandemic crisis. This study focuses on the construction players who are able to partake in the WFH arrangement and use the digital platforms as their medium to communicate. Studies showed that performance in most industries had dropped following the abrupt changes in work setting from being physically present in the office to the remote

working environment (Aon, 2020; Bartsch et al., 2021; Mohd Rahim et al., 2018; Orsini & Rodrigues, 2020; Raišiene et al., 2020). To meet the employee needs for better performance, leaders need to understand the level of employee work motivation and how to improve them as highlighted by Wang et al. (2020). In any industry, motivation is one of the most substantial factors in driving employees to improve their productivity and efficiency. As for the construction industry, it is generally accepted that highly motivated construction workers and professionals may help to improve the delivery of a construction project (Damci et al., 2020; Jarkas, 2012). Construction workers and professionals who lack work motivation can be less efficient in performing tasks, such as making decisions, managing changes, and handling problems which will turn out to negatively affect the construction project delivery (Damci et al., 2020; Pheng & Chuan, 2006; Seiler et al., 2012). Employee motivation across industries was affected, with a sharp reduction in job happiness from 69% pre-COVID-19 to 42% during the pandemic, in which the job happiness in property development in Malaysia had a massive 45% drop, which was from 76% to 31% (JobStreet, 2020). Therefore, appropriate leadership behaviours are important in maintaining employee motivation which affects work performance in navigating through uncertain times (Bartsch et al., 2021). These leadership behaviours can be classified into two-factor leadership models, which are task-oriented (TOB) leaders who focus to meet certain goals by controlling how the task should be performed and relation-oriented (ROB) leaders who focus on the interpersonal relations within the group (Bartsch et al., 2021; Ebert & Griffin, 2017; Forsyth, 2019; Lord, 1977; Yukl & Gardner, 2019). The digital readiness of employees and organisations also plays a vital role in the remote working arrangement. Findings by KPMG (2020) reported that the challenges and impact on productivity reduction during remote working settings in Malaysia included network issues (61%), productivity reduction (8%), communication barriers(14%), productivity reduction (23%), lack of technology readiness (10%) and productivity reduction (24%). These digital network challenges came from both companies and employees' homes.

58% of Malaysian employees were required to work from home during the first MCO in March 2020, including 70% from the property development industry (Job Street, 2020). Undeniably, work from home arrangements bring flexibility for the employees as work can be conducted remotely at anytime and anywhere (Mohd Rahim et al., 2018). However, the disruptive and abrupt transition to remote activities had imposed many challenges to individuals and organisations involved (Orsini & Rodrigues, 2020). A survey conducted by Retirement Solutions (2020) found several impacts on businesses in Malaysia, including increased employees' concern and stress (58%), reduced workforce productivity (30%), and absenteeism issues (21%). The Malaysian Employers Federation (MEF) also echoed, stating that there was a drop in worker productivity levels during the MCO period, as reported by Allison (2020). Specifying to the Malaysian construction industry, the Senior Works Minister Datuk Seri Fadillah Yusof reported that the most significant impacts were caused by financial issues, project delivery and labour constraints (Harun & Razak, 2020).

Much worrying, there was also a significant level of work burnout due to remote working arrangements, which led to the depletion of mental health, as reported by Sonar and Singh (2020). Therefore, appropriate leadership behaviours are important in maintaining employee motivation that affects work performance in navigating through uncertain times (Bartsch et al., 2021). Before the pandemic crisis, existing knowledge on remote working was mostly in the context of planned transition by organisations, occasional and infrequent practice, as well as a small group of employees instead of most (Wang et al., 2020). The COVID-19 pandemic

has created an unprecedented situation, whereby remote working is a compulsory requirement by the mandatory order, rather than a discretionary option by an organisation.

There is still limited literature on leadership and virtual work regarding leadership effectiveness. There was a scarcity of detailed statistics of the COVID-19 impacts on Malaysian industries, specifically regarding remote working productivity and effectiveness. Therefore, with limited literature on this subject, particularly within the construction industry, the objectives of this study were (1) to investigate the level of employee motivation in the remote working environment during the pandemic crisis in the construction industry (2) to identify the effects of task-oriented and relation-oriented leadership behaviour in motivating employees during the pandemic crisis, and (3) to determine the moderating role of digital readiness on the relation between leadership behaviour and employee motivation.

THE LITERATURE REVIEW

Employee Motivation (EM)

Work motivation affects skills that individuals develop, careers that they pursue, and the manner they allocate resources (Kanfer et al., 2017; Varma, 2017). Then, this will determine the course of decision-making and action which affect the direction, intensity, and persistence of tasks at work. Therefore, it is concluded that highly motivated employees can ensure high productivity and quality in an organisation. The Newstrom (2006) model of motivation proposes a formula which suggests that potential performance (P) is a product of ability (A) and motivation (M); hence, $P = A \times M$. This formula indicates that motivation is a significant factor to drive an employee to perform better for the benefit of the organisation. Results occur when a particular employee is provided with an opportunity, such as proper training to perform and the resources to do so. Work motivation from both intrinsic and extrinsic motivators has a significant effect on work productivity and individual performance, as well as the organisational level (Arif et al., 2019; Newstrom, 2006; Varma, 2017). Motivated employees are committed to the success of the organisational objective (Varma, 2017). Therefore, leaders need to keep their employees motivated and satisfied so that the company can successfully work towards the same goal. Since motivation originates from within each individual, it is required to understand and discover employees drives and needs (Newstrom, 2006; Varma, 2017). Because of these unique needs Jensen (2018) stated that for each employee, leaders must engage employees at work and intentionally take time to get to know each employee individually, which includes taking interest in employees outside the office.

Leadership Behaviour

Forsyth (2019) defined leadership as guidance for others in the pursuit of individual and collective goals often by directing, coordinating, motivating, supporting, and unifying their efforts with the ability to lead others. The goal for researchers to study the behavioural approach to leadership was to determine which behaviours were adopted by effective and successful leaders, as echoed by Ebert and Griffin (2017). Each work situation and context require a different leadership approach. In the context of a global pandemic crisis, Bartsch et al. (2021) reported that appropriate leadership behaviours are decisive in maintaining employees work performance and motivation in steering them through uncertain times, regardless of how severely a crisis disrupts an organisation. Leadership behaviour can be

classified into many ways. The two main clusters of behaviours that are frequently used to describe leaders could be identified by a two-factor leadership model (Forsyth, 2019). Firstly task-oriented leader behaviour (TOB) occurs when a leader focuses to meet certain goals and standards by controlling how the tasks should be performed (Ebert & Griffin, 2017). Secondly, relation-oriented leader behaviour (ROB) occurs when a leader focuses on the interpersonal relations within the group by concentrating on the satisfaction, motivation, and well-being of his employees to increase socioemotional satisfaction and teamwork in the group (Ebert & Griffin, 2017; Forsyth, 2019). Both types of behaviour possess qualities and are suitable in different work contexts and situations. Needless to say, there are combinations and a mixture of traits from these two types of behaviour in every leader. There is almost certainly no leader with only one absolute type of behaviour but rather skewed more to one of the two. Forsyth (2019) added that some people are naturally task-oriented while others are more relation-oriented; hence, people tend to favour one of these two facets when leading groups. As each type of behaviour has its qualities, a different situation means a different combination of behaviours should be adopted. In a situation when employees had to work remotely, digital readiness is identified to be the element that moderates leadership behaviour and the outcome employee motivation.

Digital Readiness (DR)

The work-from-home arrangement brings flexibility for work to be conducted remotely at anytime and anywhere (Mohd Rahim et al., 2018). However, the disruptive and abrupt transition to remote activities has imposed many challenges on individuals and organisations involved (Orsini & Rodrigues, 2020). The Malaysian Employers Federation (MEF) found a drop in worker productivity levels during the MCO period (Allison, 2020). Digital readiness can be defined as technology-related knowledge, skills, and attitudes and competencies for using digital technologies to meet the aim of an organisation's expectancies (Hong & Kim, 2018). In this study, digital is related to digital technology as a medium used to communicate for work purposes. Before the crisis, most employees had little to no remote working experience, nor they or their organisations were equipped to support such practice (Wang et al., 2020). Such vast scale and abrupt transition forced into the remote working environment had created many challenges in all affected organisations. Bartsch et al. (2021) reported that many service employees were overwhelmed by the change towards the digital-based working environment and family responsibilities became factors that triggered feelings of stress and high uncertainty. A study by Yang et al. (2020) found that working from home led to an increase in meeting hours and less focused hours. Similar results were reported by Sonar and Singh (2020), in which employees were faced with increased workload more than ever with the constant fear of losing their jobs. This increase in workload may increase stress amongst workers, which will affect their physical and mental health. In addition, those who were not ready for digital remote working may suffer a double burden (Händel et al., 2020).

Digital transformation is one of the biggest challenges leaders have to face, especially in an unprecedented situation that is triggered by a volatile, uncertain, complex, and ambiguous environment (Weber et al., 2019). In a remote working environment, task-oriented and relation-oriented leadership behaviours are considered vital to enhance employees, either individually or as a team (Bartsch et al., 2021; Liao, 2017). However, leaders are expected to face challenges in motivating geographically dispersed employees (Carte et al., 2006).

THE HYPOTHESES

The conceptual framework in Figure 1 is to illustrate the relation between the independent, dependent, and moderating variables that were used in this study. Leadership behaviour is the independent variable (IV), which has two dimensions, namely task-oriented leadership behaviour (TOB) and relation-oriented leadership behaviour (ROB). This dependent variable (DV) is hypothesised to affect employee motivation (EM). Moderating the relation between IV and DV is the moderating variable (MV), which is specifically digital readiness (DR). In total, four relations were analysed to complete the research objectives. From these relations in the conceptual framework, hypotheses for this study were formed from these relations displayed in Table 1, such as H1, H2, H3, H4, and H5.

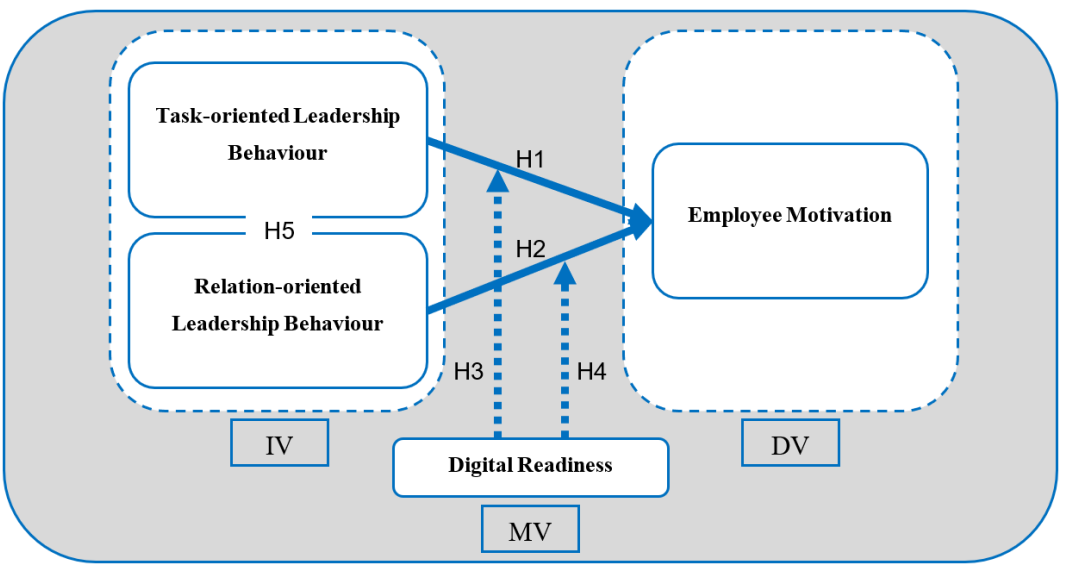

Figure 1. Conceptual Framework

Table 1. Hypotheses

Hypotheses	Statement
H1	Task-oriented leadership behaviour affects employee motivation during the pandemic crisis in the construction industry;
H2	Relation-oriented leadership behaviour affects employee motivation during the pandemic crisis in the construction industry;
H3	Digital readiness moderates the relationship between task-oriented leadership behaviour and employee motivation during the pandemic crisis in the construction industry;
H4	Digital readiness moderates the relationship between and relation-oriented leadership behaviour and employee motivation during the pandemic crisis in the construction industry; and
H5	Relation-oriented leadership behaviour has a higher impact on employee motivation than task-oriented leadership behaviour when moderated by digital readiness during the pandemic crisis in the construction industry.

RESEARCH METHODOLOGY

This research was conducted by focusing on employees of the construction industry players who were required to work remotely due to the COVID-19 pandemic crisis. The geographical scope of the research survey area was focused only on the Klang Valley areas

because they had the highest number of cases and impacts on the construction industry (Alaloul et al., 2021). As of 4 July 2021, the cumulated COVID-19 cases reported by the Ministry of Health in Selangor and Kuala Lumpur were 33.4% (259,852 cases) and 10.3% (80, 535), respectively, from the whole of Malaysia (Hawash et al., 2020). Together, Klang Valley alone had 43.7% (340,387) cumulated COVID-19 cases, which added up to almost half of Malaysian total COVID-19 cases. The limitation of this study was that it did not include construction players who could not or were not required to work remotely during this pandemic. This was justified by the fact that most contractors were required to be physically on-site and could not work remotely, which were therefore irrelevant to this study.

A quantitative approach was taken to conduct this study through a questionnaire survey. As this study covers multiple fields within the construction industry, questionnaires helped to collect a large number of quantitative data, which were electronically distributed. This was specifically suitable given that the condition during the research was conducted, whereby there was a risk in COVID-19 disease transmission and restricted movement implemented by the government. The Construction Industry Development Board (2017) it estimated that there were around 10,000 employees who were included in the study scope. Roscoe (1975) have produced a formula that a sample of size larger than 30 and smaller than 500 are appropriate for most studies, in which if a sample size of 99 respondents was appropriate for a population of 10,000 employees with ±10% precision. Therefore, the simple random sampling method was used. A total of 185 questionnaire sets were sent to employees in the construction industry. The study data was collected through a questionnaire that was conveniently distributed to relevant employees in the construction industry (architect, engineer, project manager, quantity surveyor, and government officer). Respondents were given about two weeks to complete and return the questionnaire.

The questionnaire survey was divided into four (4) sections. Section A focused on the demographic information of a respondent, including age, gender, job position, and length of services. Meanwhile, Section B emphasised the leadership behaviour of the respondent's superior. Next, Section C recorded the motivational factors of respondents. Lastly, Section D dived into the digital readiness of the organisation, in which the respondent was working. All sections used a five-point Likert scale, which were 'Strongly Agree' (5), 'Agree' '(4), 'Neutral' (3), 'Disagree' (2) and 'Strongly Disagree' (1), except for Section A. All data collected were analysed by using the statistical package for social science (SPSS) software. Various statistical tests were conducted to achieve these objectives, such as frequency, percentage, mean, factor analysis, consistency, normality, correlations, and regression.

FINDINGS AND DISCUSSION

Response Rate

As the government directions of MCO were uncertain, the data collection was done cross-sectionally for 16 days, as presented in Figure 2. As a result, 130 acceptable responses were received out of the 185 survey sets sent out, which were translated into a response rate of 70.3%. Mohd Fateh and Nijar (2019) reported that for a self-administrated questionnaire survey, the response rate usually was only 30%–40%, and thus the response rate was acceptable.

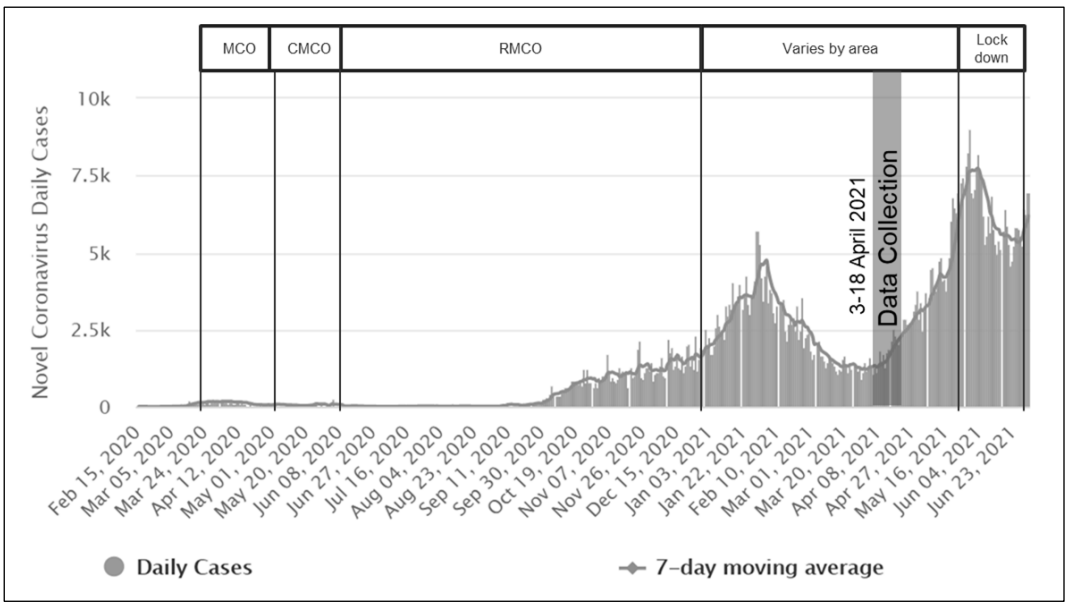

Figure 2. Daily New Cases and MCO Stages in Malaysia Concerning The Duration of Data Collection as of July 2021 (World Health Organisation, 2021)

Reliability of Data

The reliability of each item in the instruments was measured by using Cronbach's alpha value. The reliability analysis was then conducted to derive the consistency of a measuring instrument in measuring whatever concept it purports to measure. The Cronbach's alpha values of above 0.7 were generally considered acceptable, whereby all four variables were considered reliable (Sekaran & Bougie, 2016; Mohd Fateh & Yee, 2021). Table 2 illustrates the result. Meanwhile, a normality test was done to ensure that the data was normal to run further analysis. The method used for the normality test was by using skewness and kurtosis statistics. The data collected were considered to be normal if skewness was between -2 and +2 and kurtosis was between -7 and +7, according to J. F. Hair et al. (2010). Meanwhile, the value of skewness and kurtosis should be between -3 and +3 range to be considered normal (Coakes et al., 2013). Based on the test that was done, Table 3 shows that data for all variables were within the range, and thus considered acceptable.

Table 2. Reliability Test

Variables	Number of Items	Cronbach's Alpha
Task-Oriented Behaviour (TOB)	6	.914
Relation-Oriented Behaviour (ROB)	5	.890
Employee Motivation (EM)	9	.897
Digital Readiness (DR)	4	.842

Table 3. Normality Test

Variables	Skewness	Kurtosis
Task-oriented Behaviour (TOB)	-.329	-.572
Relation-oriented Behaviour (ROB)	-.376	-.529
Employee Motivation	-.447	-.423
Digital Readiness	-.858	.464

Demographic

Table 4 shows the frequency according to the respondent's profession. Most respondents were architects (41.5%). This was followed by respondents who work as engineers (26.2%), project managers (16.2%), quantity surveyors (10%), and government officers (6.2%). Meanwhile, Table 5 displays the frequency according to the type of organisation the respondents work for. The majority of respondents work for consultation firms (40.0%), followed by respondents working for developers (21.5%), contractors (20.0%), and local authorities (18.5%). The majority of respondents were fully office-based construction professionals in nature, such as consultants, developers and local authorities. Table 6 depicts the frequency according to respondent's years of experience in the construction industry. The majority of respondents have 1 to 3 years of work experience (39.2%), followed by respondents with work experience of 4 to 6 years (32.3%), 7 to 9 years (9.2%), 10 to 12 years (7.7%), 13 to 15 years (6.9%), and the remaining were 16 years and above (4.6%). Since the target respondents were employees, it justified the higher frequency of respondents with shorter work experience. Based on the findings, the demographics represent a wide range of respondents with vast working experience in construction.

Table 4. Profession of Respondents (N=130)

Profession	Frequency	Percentage
Architect	54	41.5 %
Engineer	34	26.2 %
Government Officer	8	6.2 %
Project Manager	21	16.2 %
Quantity Surveyor	13	10.0 %
TOTAL	130	100.0 %

Table 5. Organisation of Respondents (N=130)

Organisation	Frequency	Percentage
Consultant	52	40.0 %
Contractor	26	20.0 %
Developer	28	21.5 %
Local Authorities	24	18.5 %
TOTAL	130	100.0 %

Table 6. Years of Work Experience of Respondents (N=130)

Years of Work Experience	Frequency	Percentage
1 - 3	51	39.2 %
4 - 6	42	32.3 %
7 - 9	12	9.2 %
10-12	10	7.7 %
13-15	9	6.9 %
16-18	2	1.5 %
19-21	3	2.3 %
25	1	0.8 %
TOTAL	130	100.0 %

Factor Analysis

Factor analysis was used to examine the goodness of data and to simplify items. Through this analysis, a few items were analysed, which were Bartlett's Test of Sphericity, in which p-value has to be lower than 0.05 to be significant, Kaiser-Meyer-Olkin (KMO) value, which has to be above 0.60, a measure of sampling adequacy (MSA) has to be higher than 0.5, and communalities value has to be higher than 0.50. The results are shown in Table 7, Table 8, and Table 9 indicates independent variables, dependent variables, and moderating variables, respectively.

Table 7. Factor Analysis for Independent Variables

Variables	Questions		1	2
TOB2	My supervisor explains the reason for the job assignments given		.832	
TOB1	My supervisor clearly explains my job responsibilities and task assignments		.832	
TOB3	My supervisor checks for understanding of the job assignments given		.813	
TOB6	My supervisor sets specific performance goals and deadlines for important aspects of each work		.757	
TOB4	My supervisor provides necessary instruction in how to do the tasks given		.734	
TOB5	My supervisor explains priorities for different objectives or responsibilities		.667	
ROB5	My supervisor is willing to help me with personal problems			.881
ROB4	My supervisor bolsters my self-esteem and confidence			.817
ROB3	My supervisor provides sympathy and support when I am anxious or upset			.767
ROB1	My supervisor shows acceptance and positive regard towards me			.731
ROB2	My supervisor shows interest in me as an individual member of the work unit			.677
	% Variance Explained			
	KMO Measure of Sampling Adequacy			.901
	Bartlett's Test of Sphericity	Approx. Chi-Square		1024.615
		df		55
		Sig		.000

From Table 7, the result of KMO for independent variables was 0.901. According to values in the range provided by Kaiser, the KMO level of acceptance for independent variables in this study was superb (above 0.90). Therefore, it indicated that the sampling was adequate and may proceed for further factor analysis. Bartlett's Test of Sphericity for independent variables showed a significant value (Approx. Chi-Square = 1024.615, $p<0.001$). It indicated the significance of the correlation matrix and appropriateness for factor analysis. It means that if the result for Bartlett's test was highly significant ($p<0.001$), the factor analysis was applicable (J. Hair et al., 2010). The first factor consisted of six items labelled as TOB 1 to TOB 6 assessed on the supervisor's task-oriented leadership behaviour and all items were included. The factor loading for this factor was 0.667 to 0.832. The second factor consisted of five items labelled as ROB 1 to ROB 5 measured on supervisor relation-oriented behaviour and all items were included. For this dimension, the factor loading for this factor was 0.677 to 0.881. In conclusion, all 11 items in the independent variables have a high communality value (>0.5) and are thus included for further assessment.

Table 8. Factor Analysis for Dependent Variables

Variables	Questions		1
EM5	I am extremely glad that I chose this organisation to work for over others considering having to work remotely		.873
EM7	I am proud to tell others that I am part of this organisation considering the pandemic		.847
EM4	For me, this is one of the best organisations to work within the remote working environment		.845
EM1	This organisation inspires the very best in me in the way of job performance in the remote working environment		.828
EM9	I find that my values and organisation's values are very similar considering the pandemic		.780
EM8	I would accept almost any job to keep working for this organisation during the pandemic		.754
EM6	I care about the fate of this organisation during the pandemic		.664
EM2	I know what is expected of me at my job when working remotely		.512
EM3	I can do what I do best every day when working remotely		
	% Variance Explained		
	KMO Measure of Sampling Adequacy		.847
	Bartlett's Test of Sphericity	Approx. Chi-Square	700.936
		df	36
		Sig	.000

From Table 8, the result of KMO for dependent variables was 0.847. According to values in the range provided by Kaiser Meyer Olkin (2018), the KMO level of acceptance for independent variables in this study was great (0.80 to 0.90). Therefore, it indicated that the sampling was adequate and may further proceed for factor analysis. Bartlett's Test of Sphericity for independent variables showed a significant value (Approx. Chi-Square = 700.936, $p<0.001$). It indicated the significance of the correlation matrix and appropriateness for factor analysis. It means that if the result for Bartlett's test was highly significant ($p<0.001$), the factor analysis was applicable (J. Hair et al., 2010). All nine items labelled as EM1 to EM9 were assessed for employee motivation. The factor loading for this factor was 0.512 to 0.873. One of the items, EM3, was removed due to a low communality value (<0.5).

Table 9. Factor Analysis for Moderating Variables

Variables	Questions		1
DR3	I can easily share my files with colleagues using online software		.886
DR4	I can easily collaborate with colleagues using online software		.885
DR2	I can freely share my opinion online (e.g., with social media or web pages)		.774
DR1	I can interact with colleagues using real-time communication tools without interruption (e.g., video conferencing tools or messengers)		.758
	% Variance Explained		
	KMO Measure of Sampling Adequacy		.771
	Bartlett's Test of Sphericity	Approx. Chi-Square	231.335
		df	6
		Sig	.000

From Table 9, the result of KMO for moderating variables was 0.847. According to values in the range provided by Kaiser Meyer Olkin (2018), the KMO level of acceptance for

independent variables in this study was good (0.70 to 0.80). Therefore, it indicated that the sampling was adequate and may further proceed for factor analysis. Bartlett's Test of Sphericity for independent variables showed a significant value (Approx. Chi-Square = 231.335, $p<0.001$). It indicated the significance of the correlation matrix and appropriateness for factor analysis. It means that if the result for Bartlett's test was highly significant ($p<0.001$), the factor analysis was applicable (J. Hair et al., 2010). All four items labelled as DR1 to DR4 were assessed for digital readiness. The factor loading for this factor was 0.758 to 0.886. All items in the independent variables have a high communality value (>0.5) and were therefore included to be further analysed.

Descriptive Analysis

As shown in Table 10, the mean score for independent variables TOB was 3.83, which was in the high-level range. However, the mean score for ROB, was 3.64 which was in the medium-range. The mean score for the dependent variable was 3.77, which was also in the high-level range. Finally, the mean score for the moderating variable was found to be in the high-level range with a score of 4.00.

Table 10. Descriptive Statistics

Variables	Mean	Std. Deviation
Task-oriented Behaviour (TOB)	3.83	.827
Relation-oriented Behaviour (ROB)	3.64	.938
Employee Motivation (EM)	3.77	.871
Digital Readiness (DR)	4.00	.827

The Level of Employee Motivation in Remote Working Environment During the Pandemic Crisis in The Construction Industry

The descriptive analysis can be read based on mean and standard deviation. Based on (Thaoprom, 2004), the mean score was divided into high (3.68 – 5.00), medium (2.34 – 3.67), and low (1.00 – 2.33). As shown in Table 10, the mean score for employee motivation was 3.77, which placed it in the high range. The findings indicated that the work motivation level of employees working in a remote setting was generally high. However, it was at the lower range of high level, which opened room for improvement. To get into context, the data was collected in April 2021, which was 13 months after the first MCO was enforced in March 2020. After more than a year since the first MCO, the strongest factor that keeps employees highly motivated was the fact that they understood what was expected of them concerning their jobs despite having to work remotely. This result was aligned with the higher level of task-oriented traits to compare to relation-oriented in leaders. Task-oriented leaders are known to be good at giving instructions to their subordinates and the results implied that employees will get motivated if their leaders can communicate clearly with them in setting work goals and objectives (Lord, 1977; Orsini & Rodrigues, 2020; Yukl & Gardner, 2019).

The second factor for high motivation amongst employees was that the employees could do their best at work every day despite physically working away from their organisations. This finding suggested that as long as the employees could work properly, regardless of the condition, time, and/or location, such a situation would motivate them, wherever and however they perform their work. As such, leaders should support their employees to ensure that they

could work from home with the proper guidance, tools, and equipment required to do so (Bartsch et al., 2021; Wang et al., 2020).

The majority of respondents cared about the fate of their organisations during this pandemic, which implied that employees who have strong attachments with their company have high work motivation. The result makes sense as the fate of employees is bonded to the fate of their organisations. In this case, leaders play a pivotal role to remind employees about the importance of keeping the company afloat during such a crisis with the unity amongst employees as an entity (Bartsch et al., 2021).

The Effects of Task-Oriented and Relation-Oriented Leadership Behaviour in Motivating Employees During the Pandemic Crisis

The purpose to do correlations analysis was to evaluate the relation strengths between two variables. Therefore, Pearson correlation analysis was done with the interpretation of correlation coefficient based on Salkind (2018) interpretation in Table 11.

Table 11. Interpretation of Correlation Coefficient

Scores	Level
±0.8 to 1.0	Very strong correlation
±0.6 to 0.8	Strong correlation
±0.4 to 0.6	Moderate correlation
±0.2 to 0.4	Weak correlation
±0.0 to 0.2	Very weak correlation

A Pearson product-moment correlation was run to determine the relation between task-oriented leadership behaviour and employee motivation. Referring to Table 12, there was a strong and positive correlation between task-oriented leadership behaviour and statistically significant employee motivation ($r = .521$, $p < .001$). Therefore, H1 was accepted. Similarly, there was also a strong and positive correlation between relation-oriented leadership behaviour and employee motivation, which was also statistically significant ($r = .624$, $p < .001$). Therefore, H2 was accepted.

Table 12. Correlation of Leadership Behaviour with Employee Motivation

Variables		Task-oriented Leadership Behaviour	Relation-oriented Leadership Behaviour
Employee Motivation	Pearson Correlation	.521	.624
	Sig. (2-tailed)	.000	.000
	N	130	130

The result of the study revealed that there were significant and positive impacts of both tasks- and relation-oriented leadership behaviours in motivating employees during the pandemic crisis. This result was consistent with the previous research done by Azman et al. (2020). As shown in Table 10, TOB was found to be in the high range of mean score, suggesting that most leaders in the construction industry were leaning more towards being task-oriented. In general, leaders were doing well in setting specific performance goals and deadlines for important aspects of employee's works. Additionally, leaders were also good at explaining employee's job responsibilities and task assignments clearly during the remote working environment. Taken together, these results suggested that employees feel motivated

when they are given concise goals and instructions despite working in isolation. It is encouraging to compare these figures with those found by Bartsch et al. (2020), which established that leaders who engaged in task-oriented behaviour and provided guidance and set a clear direction, had helped to improve teamwork in a rapidly emerging virtual work environment.

On the contrary, ROB was analysed to be in the medium range of mean score, as shown in Table 10. This implied that leaders in the construction industry were less relation oriented. Nevertheless, there was an interesting result, in which ROB was found to have a higher impact on employee motivation as compared to TOB. Overall, this study strengthened the idea that leaders should enhance themselves to be more relation oriented to improve the motivation of their employees. Generally, leaders were found lacking in showing a willingness to help their employees with personal problems. Moreover, leaders were not showing enough sympathy and support when their employees were anxious or upset due to the exhaustion of working in isolation. The results have also shown that employees require more intimate and personalised interaction with their leaders concerning work as well as personal life. One possible reason for this was because employees felt disconnected and uncared for when working alone (Hadley & Mortensen, 2021; Hansen et al., 2021). In a study by Hansen et al. (2021), it was reported that people who felt lonely cannot do their best work, which means that teams with lonely member were not operating at their peak levels either. These results reflect those of Bartsch et al. (2020) who also found that leaders granting employees the necessary support individually, enables them to adapt to difficult crisis-induced circumstances.

This combination of findings provided some support for the conceptual premise that both TOB and ROB were important to keep employees motivated. More importantly, although leaders were mostly good at being task-oriented, they will have to enhance their relation-oriented behaviour to further increase employee motivation in a remote working environment. The scarcity of social interaction caused by MCOs and lockdowns have made employees yearned for more personal relations at work.

The Moderating Role of Digital Readiness on The Relationship Between Leadership Behaviour and Employee Motivation

Hierarchical regression analysis was used to measure the percentage of the dependent variable can be explained by the independent variable and the other variables, including moderating variable. In this study, the researcher wanted to examine the extent of moderating variable (digital readiness) in moderating the relation between leadership behaviour (TOB and ROB) and employee motivation. The result for hierarchical regression analysis is shown in the table below.

Table 13 and Table 14 summarise the results of the moderating effect of digital readiness on the relation between task-oriented leadership behaviour and employee motivation. Model 1 in Table 13 reflected the direct relation between leadership behaviour and employee motivation while Model 2 signified the extent of additional variance explained when the moderator was included in the regression model. Meanwhile, Model 3 highlighted the interaction of moderating variables with the independent variable and their relationship with the dependent variable. Concurrently, R2 is the variance in the dependent variable (employee motivation), which can be predicted from the independent variable.

Table 13. Hierarchical Regression Analysis for TOB

	Dependent Variable Employee Motivation		
	Model 1	**Model 2**	**Model 3**
Task-Oriented Leadership Behavior	.521**	.334**	.389
Digital Readiness		.495**	.543*
Task-Oriented Leadership Behavior x Digital Readiness			-.086
R^2	.271	.482	.482
R^2 Change	.271	.210	.000
F Change	47.699**	51.549**	.037

Note: Significance at *p<0.005, **p<0.01

Table 13 summarises the results of the moderating effect of digital readiness on the relation between TOB and employee motivation. From the findings, Model 1 indicated 27.1% of the variance in the dependent variable (employee motivation) while Model 2 showed 48.2%, an additional of 21.1% higher than the variance in Model 1, whereas, for Model 3, it indicated 48.2% of the variance, which there was no change from Model 2. According to the results, there was no significant interaction of digital readiness between task-oriented leadership behaviour and employee motivation. The interaction between task-oriented leadership behaviour and digital readiness was (β=-.086, $p>0.05$). Based on the result obtained, the predicted result that digital readiness would moderate the relation between task-oriented leadership behaviour and employee motivation was not significant. From the hierarchical regression table above, it could be concluded that there was no moderating effect of digital readiness on the relation between task-oriented leadership behaviour and employee motivation. Therefore, the H3 was not supported.

Table 14. Hierarchical Regression Analysis for ROB

	Dependent Variable Employee Motivation		
	Model 1	**Model 2**	**Model 3**
Relation-Oriented Leadership Behavior	.624**	.456**	.314
Digital Readiness		.452**	.349
Relation-Oriented Leadership Behavior x Digital Readiness			.206
R^2	.389	.565	.566
R^2 Change	.389	.176	.001
F Change	81.573**	51.375**	.261

Note: Significance at *p<0.005, **p<0.01

Table 14 shows the results of the moderating effect of digital readiness on the relation between ROB and employee motivation. From the findings, Model 1 indicated 38.9% of the variance in the dependent variable (employee motivation) while Model 2 showed 56.5%, an additional of 17.6% higher than the variance in Model 1, whereas, for Model 3, it indicated 56.6% of the variance, which there was an increase of 0.01% from the Model 2. Similar to task-oriented behaviour, there is no significant interaction of digital readiness between relation-oriented leadership behaviour and employee motivation. The interaction between relation-oriented leadership behaviour and digital readiness was (β=.021, $p>0.05$). Based on the result obtained, the predicted result that digital readiness would moderate the relation between relation-oriented leadership behaviour and employee motivation was not significant as well. From the hierarchical regression tables above, it could be concluded that there was no moderating effect of digital readiness on the relation between task-oriented leadership

behaviour and employee motivation. Therefore, the H4 was not supported. Comparing both tables (i.e., Table 13 and Table 14), it could also be identified that ROB (r = 0.624) had a higher impact on employee motivation than TOB (r = .521). Therefore, it was concluded that H5 was accepted.

The results of this study had shown that there was no moderating effect of digital readiness on the relation between leadership behaviour and employee motivation. This rejected the expected result that employee digital readiness would have some ability to moderate between the independent and dependent variables. In a previous study, Wang et al. (2020) proposed that before the pandemic, most employee had little to no remote working experience, and both employees and their organisations were not equipped to support such practice. The abrupt change to the digital work setting had caused stress amongst employees at the start of the pandemic, while communication between superior and employees was impaired for those who were not digitally prepared (Bartsch et al., 2021; Wang et al., 2020). One possible reason for the insignificant moderating effect of digital readiness could be explained by the long gap between the first lockdown and data collection activities, which were carried out approximately 13 months later. At time the data were collected, the result suggested that employees were already able to interact, share opinions and documents, as well as collaborate with their colleagues through digital platforms without any difficulties. The lengthy duration may have given employees and their organisations long enough time to equip themselves with the much-needed reliable digital platform for work. Employees and employers may have gotten used to working remotely by using these digital platforms. The industry's quick adaptation to digital work settings has eventually become a limitation. To summarise, employees were digitally ready and have gotten familiar with working remotely by using digital platforms at the time data collection was conducted. The result of the moderating role might have been different if it was done in the earlier period of the pandemic crisis, whereby employees and their organisations did not see such a crisis coming, and thus, were not digitally ready.

Hypotheses Results

All the findings stated help to conclude the result of hypotheses that answer each relation between dependent, independent, and moderating variables. The effects of task-oriented and relation-oriented leadership behaviour in motivating employees during the pandemic crisis were tested by using correlation coefficient analysis. It was found that TOB and ROB affected EM during this particular environment. Therefore, H1 and H2 were proven and supported. With the same analysis, it was also found that ROB had a higher impact on EM than TOB did in the same context which consequently supported H5. It was found that DR did not moderate both relations of TOB and EM, as well as the relationship of ROB and EM. It can be concluded from these findings that H3 and H4 were not supported. To summarise, the results of the hypotheses are shown in Table 15. It can be observed that 3 out of 5 hypotheses were supported.

Table 15. Result of Hypotheses

Hypotheses	Statements	Results
H1	Task-oriented leadership behaviour affects employee motivation during the pandemic crisis in the construction industry.	Supported
H2	Relation-oriented leadership behaviour affects employee motivation during the pandemic crisis in the construction industry.	Supported
H3	Digital readiness moderates the relationship between task-oriented leadership behaviour and employee motivation during the pandemic crisis in the construction industry.	Not Supported
H4	Digital readiness moderates the relationship between and relation-oriented leadership behaviour and employee motivation during the pandemic crisis in the construction industry.	Not Supported
H5	Relation-oriented leadership behaviour has a higher impact on employee motivation than task-oriented leadership behaviour when moderated by digital readiness during the pandemic crisis in the construction industry.	Supported

CONCLUSION

Employee motivation is vital in maintaining work productivity. The series of lockdowns due to the pandemic has brought people down to the hierarchy of needs level. Those who had ample love and a sense of belonging may have lost them to isolation during the pandemic crisis. Those who had solid safety needs have gotten insecure with weakening job security. Out of those needs, a sense of connection and belonging could be provided by employers through many methods. In the scarcity of these basic requirements, organisations could play a role by offering a more personal and intimate connection with their employees. This would help to increase the much-needed motivation to work and perform at work. As personal interaction is lacking in the digital work environment, leaders need to learn to be more relation-oriented in a distant-working environment. Actions as simple as giving praises and showing empathy are important in such situations. This is particularly important for Malaysians, in which the culture is leaning significantly towards being collectivist rather than individualistic. In hopes of contributing to the Malaysian construction industry as well as sustainability, this study was parallel with the United Nation Sustainable Development Goals (UNSDG), which mainly focuses on goals: good health and wellbeing (No.3), decent work and economic growth (No.8), and Industry, Innovation and Infrastructure (No.9). These are in line with the fact that the construction industry plays a vital role in the Malaysian Construction Industry Transformation Program (CITP).

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THE INFLUENCE OF ORGANIZATIONAL READINESS IN THE DEVELOPMENT OF SMART CITY PROJECTS

Nur Shahirah Nadhilah Wahab[1], Seow Ta Wee[1,2], Norliana Sarpin[1,2] and Haryati Shafii[1,2]
[1]Department of Construction Management, Faculty of Technology Management & Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor, Malaysia.
[2]Center of Sustainable Infrastructure & Environmental Management (CSIEM), Faculty of Technology Management & Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor, Malaysia.

Abstract
The city key players nowadays are focusing more on the integration of smart city concept in the development of cities. The strategic change through the development of smart cities is important to overcome various urban challenges. However, it is still remaining a challenge for the city key players to convey the smart city strategies into actual project. Past researches have pointed out the importance of the readiness at the organizational level. Therefore, this study focuses on the organizational readiness for Change Theory to better understand the fundamental of the concept. Furthermore, this study discusses the organizational readiness in digital innovation and relating it to the smart city perspective. Finally, the study briefly discusses the past studies to review the assimilation of smart city and the organizational readiness. This study concludes the potential of new research area that could be explored in order to better understand the concept as well as to aid the city key players for future smart city developments.

Keywords: *Smart city; readiness; organizational readiness.*

INTRODUCTION

The development of smart city has gained interest of both industry and academia since this topic can be considered as a new topic as it has only started to bloom since the mid-2010s (Anthopoulos, 2017; Schipper & Silvius, 2018). In a study done by Mahesa, Yudoko, & Anggoro (2019), they had emphasized on that there are three elements that should be focused on in order to develop smart cites; structure (i.e., human capital, financial capital, and governance capital); infrastructure (i.e., physical, digital and social); and superstructure (i.e., regional regulations, institutional and implementation development based on smart city aspects). The issue arises when some of the cities has the potential to develop the smart cities as they have been equipped with sufficient structure and infrastructure readiness but are still lacking in the superstructure area.

Lokuge, Sedera, Grover, & Xu (2019) explained that although the cities might have been equipped with advanced technologies, such as cloud, IoT, business analytics, and resources, they are not immune to innovation failure. Furthermore, it is said that one of prominent issues regarding the challenges in implementing smart cities is the governance (Izzuddin & Arifin, 2019). They further explained that there are a few elements under the governance, including the organizational culture for stakeholders, leadership support, management support from technology providers, procurement and maintenance budgets, and standardization of information security management (Izzuddin & Arifin, 2019).

This study is focusing on the brief review of the Organizational Readiness for Change Theory. This study is also looking through the perspective of organizational readiness for digital innovation in which is further relate it to the smart city context. Finally, a brief review

on the past literature on the topic of readiness towards smart city development is discussed in this study.

LITERATURE REVIEW

Organizational Readiness for Change Theory

In 2009, Bryan J. Weiner has introduced the Organizational Readiness for Change Theory. It was drawn by taking the consideration of Lewin's Model of Change which was presented in 1951 (Weiner, Amick, & Lee, 2008). According to the model, organizations should be "unfreeze" first and this could be achieved by changing the mind-set and creating the motivation to change (Weiner et al., 2008). Weiner (2009) explained that the readiness can be theorized, assessed, and studied at any level such as individual, group, unit, department or organizational. However, the construct's meaning, measurement, and relationships with other variables are different from each level.

Weiner (2009) further describe organizational readiness as "organizational member's change commitment and change efficacy to implement organizational change". In general, the term "readiness" could be conveyed as the state of being both psychologically and behaviourally prepared to take action (Weiner, 2009; Weiner et al., 2008). Meanwhile, Helfrich et al. (2011) described the term as "a state that is attained prior to the commencement of a specific activity in relation to psychological, behavioural and structural preparedness of the organizations".

This theory stresses on the organizational structure and resource revenues which are said to shape the readiness perceptions (Weiner, 2009). There are three main elements which influence the organizational readiness for change, and they are (i) change valance, (ii) change efficacy, and (iii) contextual factors (Weiner, 2009). Firstly, change valance focuses on the urgency support and commitment or organizational members for change and it observes whether the members value the change of its implementation (Lokuge, Sedera, Grover, & Dongming, 2019; Weiner, 2009). Secondly, the change efficacy is the organization's judgement of perceived capability to perform task where it takes consideration of a few aspects including human, financial, material and information resources (Lokuge, Sedera, Grover, & Dongming, 2019; Weiner, 2009). The third element, contextual factors highlight other aspects such as the importance of organizational culture, learning requirement, organizational strategies, partnership and organizational procedures in promoting the change (Lokuge, Sedera, Grover, & Dongming, 2019; Weiner, 2009). Thus, this study focuses on the importance to understand the readiness of an organization to implement a strategy in order to fully conveying the goals.

Organizational Readiness in The Context of Smart City

A study was done in 2019 by Lokuge, Sedera, Grover, & Dongming to understand the organizational readiness for change in the context of innovation. According to Lokuge, Sedera, Grover, & Dongming (2019), innovation is a "production or adoption, assimilation and exploitation of a value-added novelty in economic and social sphere; renewal and enlargement of products; services and markets; development of new methods of production; and the establishment of new management systems". They also highlighted that digital

innovation is the innovation which being enabled by digital technologies. Thus, digital technologies could facilitate everyday life activities. They further suggested that innovation can be made only when the organization is ready to change its approach continuously.

There are two views regarding the study on the term of "readiness" and "innovation"; (1) the readiness of an organization to withstand an innovation; and (2) the readiness of an organization to deliver or enable innovation (Lokuge, Sedera, Grover, & Dongming, 2019). This study however is focusing on the second view, in which to understand the level of readiness of the organizations to deliver strategies of smart city onto the development of cities. In broader sense, a few studies have been done in different disciplines such as healthcare, management and information system (IS). For example, in health discipline, there have been studies on the implementation of new technologies into treatment program (Buabbas & Alshawaf, 2019), the readiness of the organization to implement new practices (Bornheimer, Acri, Parchment, & McKay, 2019), and also the interactions among different factors of organizational change in service sector (Vaishnavi, Suresh, & Dutta, 2019).

The management discipline too, has shown a few recent studies conducted on the understanding of the readiness to implement new practices on construction area (Chen, Yin, Browne, & Li, 2019), the readiness level of the school community to adopt new syllabus (Lee et al., 2019), and also the study on the organizational readiness of the hotel management to upgrade and serve new local cuisines to enhance the hotel performance by utilizing tourism campaigning (Bondzi-Simpson & Ayeh, 2019).

The Information System (IS) area has also seen a significant number of studies regarding the organizational readiness, such as the study on the organizational readiness to adopt new technology system in the organization (Clohessy & Acton, 2019; Yuniarty, Prabowo, & Noegraheni, 2019), the study on the organizational readiness towards the change for innovation delivery (Lokuge, Sedera, Grover, & Dongming, 2019), and implementation of technology (Gürdür, El-khoury, & Törngren, 2019).

Lokuge, Sedera, Grover and Xu (2019) stated that rather than evaluating one as "ready" or "not ready", it is best to conceptualized readiness as a degree of readiness. This could further be understood that organizations could produce or adopt, comprehend, and utilize innovation if the changes are (1) perceived as necessary (willingness) and (2) the organizations the required capabilities (ability) (Lokuge, Sedera, Grover, & Xu, 2019). The main objective of the study done by Lokuge, Sedera, Grover and Xu were to derive a model for organizational readiness for digital innovation. Thus, they had developed a model which was derived based on the Organizational Readiness for Change Theory by Weiner which being discussed before. They had outlined seven elements in which to gauge organizational readiness for digital innovation.

Based on the model proposed by Lokuge, Sedera, Grover and Xu (2019), there are seven factors or elements which influence the organizational readiness for digital innovation, which are resource readiness, cultural readiness, strategic readiness, IT readiness, innovation valance, cognitive readiness, and partnership readiness. Since the development of smart cities involves innovation, thus, it is able to fundamentally be related to the digital innovation process. Furthermore, based on the Organizational Readiness for Digital Innovation model,

we can further study the concept and understand how it will influence on the organizational readiness for smart city development.

DISCUSSION

The Readiness Towards Smart City Development

The evolution from a city to a smart city is a big step, it is inevitable to be exposed to many risks and challenges in trying to implement the strategies. A few studies have been done on the issue regarding the challenges in implementing and delivering the idea of smart city concept on actual projects. There are three types of challenges associated with the implementation of smart city concept on actual city developments; (i) operational challenges, (ii) strategic challenges, and (iii) external challenges (Čukušić, Jadrić, & Mijač, 2019). Taking example from study a done by (Ojo, Curry, Janowski, & Dzhusupova, 2015), where they found different factors of challenges for different cities, such as Songdo (Korea) city, where they had faced issue regarding the alignment of interest and commitments of all the key players, where they found hindrance while establishing the level of development, and also to establish the cooperation between the parties to follow the guidelines that have been set up. Further, they found through the study that the city of Masdar (UAE) had faced global economic slowdown due to lack of capital and lower prices of oil and another example is the city of Tianjin (China), where they faced difficulties in achieving residents' participation to effectively reinforce the polies and programs done by the government (Ojo et al., 2015).

Another example of challenges is found in a study done by Jaafar, Sharif, Ghareb, & Jawawi (2019), where they focuses on the technological aspect in which some of the cities faced heterogeneity and interoperability challenges (i.e. the need to have more sophisticated architecture, platform and middleware for the ICT), technology challenges (i.e. the problems associated with the device capabilities, integration of multiple cloud services, data management, intelligent analysis, security and privacy), and data challenges (i.e. the issues with the real-time monitoring of the physical world). There are a few other challenges that have been determined over the past few years. However, it was argued that most of the work presented belongs to the category of experimental test benches (i.e., pilot cities), in which the transforming a test bench experience into real world is a very difficult task (Saba, Sahli, Berbaoui, & Maouedj, 2020).

A few researches had agreed that there is the need for a "preparation" phase and also the governments as well as the other key players need to assess the readiness of the targeted cities before deploying the smart city strategies (Achmad, Nugroho, Djunaedi, & Widyawan, 2018; Calderon, Lopez, & Marin, 2018; Gunawan, 2019; Mahesa et al., 2019; Mishra, Sen, & Kumar, 2017). The administrative structure needs to change first before the potential benefit from the aims could be achieved (Argento, Grossi, Jääskeläinen, Servalli, & Suomala, 2019). Thus, this could lead to the organizational readiness of the key players in moving towards the implementation of smart cities development.

There are a few past studies which have been done in order to assess the readiness to implement smart cities strategies in a few countries. For example, the study done by (Mahesa et al., 2019), the study was done to determine the regional readiness of the selected cities by taking into account the three main elements which are the structures; infrastructures; and

superstructures and also the six pillars of smart cities. They had utilized the first part of study to determine the readiness indicator through interviews and secondary data and they quantified the data obtained and being addressed to the selected cities in Indonesia.

In the study done by Izzuddin & Arifin (2019), they had outlined five elements which are being associated with the readiness to implement big data in Jakarta. The five elements, including the data management, infrastructure, governance, human resources and data analysis. Through the study, they had pointed out some of the current conditions which are affecting the implementation of big data in the city. Some of the conditions, including that there is lack of care Local Government Organization towards data and incomplete data; there is lack of number of Data Scientist as a big data processing staff that has expertise in data analysis; there is the unavailability of Quality of Service management; and the organization responsible has limited authority in implementation (Izzuddin & Arifin, 2019).

In general, most of the studies that have been done were focusing on the general readiness in the implementation of smart cities. However, a few past studies have been pointing out the challenges may due to the governance or the lack of efficiency of the organizations in implementing the smart city strategies, in which the studies found that some of the cities were not able to fully perform on the strategies due to issues such as the lack of clarity on setting the goals, the unclear alignment of interests and commitment plans of the cities' key players, the lack on resource management, the lack of leadership to adhere the implementation plan and also the lack of involvement of planners in smart city initiatives (Argento et al., 2019; Ojo et al., 2015; Wahab, Seow, Radzuan, & Mohamed, 2020; Zheng & Sieber, 2019).

Thus, when taking consideration of the topic of organizational readiness for change in the context of smart city, through the literature research, it shows that the assimilation of these two elements (i.e., smart city and organizational readiness for change theory) is still lacking in the research area. To date, there are two prominent research that have been done to study in area. One of the studies was done by Dewi, Hidayanto, Purwandari, Kosandi, & Budi (2018) in which the objective of the study was to design a smart city readiness model based on the technology-organization-environment (TOE) framework. They had studied the three main elements (i.e., the technological readiness, organizational readiness and environmental readiness) which involves the local authorities in order to know the impact of the elements on the adoption of smart city strategies.

Through the study, the result had shown that the readiness of the internal organization itself is the most significant factor that influence the intention of local government to adopt smart city goals and strategies. They had also stressed on the importance to evaluate organizational readiness of the local government before implementing the smart city strategies (Dewi et al., 2018). Some of the elements being stresses on with regards to the organizational readiness is the structure, culture, objectives, size, quality of resources and the decision-making mechanisms. However, since the study only focusing on three factors of organizational readiness, which are the IT professional support, top management support and viable funding strategy, thus, there is the need to further explore this research area in order to have deeper understanding on the relation of organizational readiness with the smart city development.

Another study was done by Guenduez & Mergel (2022), where they were focusing on dynamic managerial capabilities of smart city managers and the organizational readiness of a city administration required to drive smart city transformation. The study was done by conducting semi-structured interviews with smart city managers of cities which were being listed on the IMD Smart City Index (Guenduez & Mergel, 2022). The study was more comprehensive since it focusses both on the managerial and the administrative aspects of the organization. Through the study, it was found that there are five dynamic managerial capabilities for smart city transformation; sensing, seizing, innovation, and empowering capability. While, for the organizational factors, they have outlined four important elements which are innovation readiness, resource readiness, participatory and collaborative mindset, and strategic readiness (Guenduez & Mergel, 2022).

The outcome of the study stresses out that the capacity and the capabilities of a city administration are the most important aspect in a transforming strategically towards smart city. Moreover, it is said that the smart city managers need to invest more efforts into creating the necessary organizational conditions when the city administration's organizational readiness is low. Though the study was more comprehensive, there were still some untouched areas within the study scope. For example, the study focused on the management's role in smart city transformation process, but they did not integrate managerial decisions into their model. According to the study, they did not consider some of these elements in the study, including managerial cognition, managerial social capital and managerial human capital. Furthermore, they have suggested since smart cities are collaborative ecosystems, thus there should be the integration of other urban stakeholders in order to fully understand the strategic transformation towards smart cities (Guenduez & Mergel, 2022). However, in their study, they did not explore the integration of the said urban stakeholders.

CONCLUSION

The development and the transformation of cities towards smart cities are growing every day. Although the concept has been integrated in the modern development for some period of time, researches have learned that it is inevitable to come across some issues and challenges while trying to implement the smart cities strategies into actual projects. There are a lot of different challenges that have been faced by the key players of these developed smart cities and can be categorized as (i) operational challenges, (ii) strategic challenges, and (iii) external challenges (Čukušić et al., 2019). However, through the review of literature, most of the challenges regarding the development of smart city were pointing towards the governance or the strategic implementation of the involved organizations. This included the lack of efficiency of the organizations in implementing the smart city strategies, in which the studies found that some of the cities were not able to fully perform on the strategies due to issues such as the lack of clarity on setting the goals, the unclear alignment of interests and commitment plans of the cities' key players, the lack on resource management, the lack of leadership to adhere the implementation plan and also the lack of involvement of planners in smart city initiatives (Argento et al., 2019; Ojo et al., 2015; Wahab et al., 2020; Zheng & Sieber, 2019). Thus, the "preparedness" or the "readiness" becomes one of the most important elements in order to ensure that the future development of smart cities can be done efficiently.

In order to explore more about this issue, there is the need to extend the area of research to further understand the topic of organizational readiness as it is the core of transformation when there in the involvement of a change. Through the study, it shows that most of the past research has focused on the readiness as a whole. It was also shown that the assimilation of the smart city and the organizational readiness for change theory is still lacking in the research area. Therefore, this provides an opportunity to further explore about this topic. It is important to understand the organizational readiness in the perspective of smart city development as it is needed to overcome the mentioned issues or challenges in previous part. Future studies which focus on this topic will not only contribute to the body of knowledge, but if more comprehensive study can be done which involves more key players of smart cities will also aid the construction industry to develop smart cities more efficiently.

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AN INCEPTION INVESTIGATION OF BUILDING INFORMATION MODELLING (BIM) ADOPTION IN FACILITIES MANAGEMENT PRACTICES: DEVELOPER INSIGHTS

Md. Asrul Nasid Masrom[1,2], Muhammad Izarul Hafiz Alias[1] and Junaidi Ahamad[3]
[1]Department of Construction Management, Faculty of Technology Management & Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor, Malaysia.
[2]Centre of Sustainable Infrastructure and Environmental Management (CSIEM), Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Batu Pahat, Johor, Malaysia.
[3]Juru Wajar Sdn. Bhd., 73, Jalan Rukun 4, Happy Garden, Off Jalan Kuchai Lama, Kuala Lumpur.

Abstract
The adoption of Building Information Modelling (BIM) constitutes a paradigm shift in the facilities management industry. By utilizing the BIM process, the facilities management players could plan, coordinate, and monitor in an effective integrated approach. This is one of the many benefits that they could gain and resulting in increased efficiency. Despite these benefits, the implementation of BIM in the Malaysian Facilities Management (FM) industry is still at an infant stage. The objective of the study is to identify the challenges and investigate the strategies to improve the adoption of BIM technology in FM mainly based on developer insights. This study was conducted using a qualitative method by interviewing three (3) representatives from facilities management company around Johor. All the feedback and information gain from the interview session is analysed using content analysis method. The result of the interview addressed that the challenges adopting BIM in FM include human factor, process factor, cost factor, technology factor and risk factor. Furthermore, to improve this adoption several strategies had been outlined by the respondents such as offer BIM testimonials, create more BIM projects and develop BIM training or courses systematically. This preliminary study would be beneficial towards the FM practices in adopting BIM for better planning and increased efficiency at managing and maintaining the building or properties.

Keywords: *Adoption; implementation; Building Information Modelling (BIM); Facilities Management (FM); developer.*

INTRODUCTION

Buildings are one of a country's most precious resources because they give people a place to live and spaces for work and recreation. Building management and upkeep become crucial processes as time goes on for maintaining a building's worth and quality (Vijverberg, 2002). The value of buildings depends on the quality of the maintenance invested in them (Lateef, 2009). Across the globe, governments spend a lot of money on maintenance and operating initiatives (Al-Arjani, 2002). Hence, the environment in this industry has become complex and competitive, because of globalization, internalization of markets, and liberalization of trade, deregulation, and the knowledge economy (Hari et al., 2005). The paradigm shift in building monitoring and maintenance process is experiencing an increased transfer of technology from developed nations to developing nations. As Industry 4.0 has extended the use of sensors in buildings and infrastructure (Mario Claudio et al., 2021). According to Malaysia Productivity Corporation (2015), there are still untapped prospects to increase productivity through mechanisation, automation, and modern building systems, such as the usage of Facility Information Modelling (BIM) for controlling and maintaining the building.

Generally, facilities managers have only been significantly involved in the building lifespan and at the final stage of facility handover to clients (public or private) (Azhar, 2011). Their roles and responsibilities in providing the relevant information and maintaining the demonstration are not clearly defined (Becerik-Gerber et al., 2012). Additionally, the effects of design decisions on operational costs or maintenance are also typically not contested (British Institute of Facilities Management, 2012). In such a way, this led to poor and ineffective facilities management practice due to insufficient of information and doubtful ability to support the core business objective.

There are several recent scholars that have recommended for software adoption in this industry towards optimising by integrating people, place, process, and technology such as BIM. According to House et al. (2007), adoption of BIM in a building lead to more successful and effective facilities management work. This supported by Aziz et al. (2016), which stated that BIM offer digital visualization for collection of database tools, particularly for the life-cycle FM in building operations. Although the awareness of using BIM has been widely proven, however, an in-depth exploration of BIM adoption at the end-of-life cycle stage in construction project is still undetermined. Consequently, this scenario motivates this paper to investigate the challenges and ways to overcome the situation based on developer point of view.

LITERATURE REVIEW

Definition of Building Information Modelling (BIM)

BIM is currently a crucial piece of information for the AECO (Architecture, Engineering, Construction, and Operations) sector (Succar, 2009). BIM has proven its viability in a number of contexts, including facility management (FM) (Pottinger et al., 2015), lean management (LM) (Anumba et al., 2019), and more recently we can see in the railway industry (Mharzi et al., 2019). Digital representation tools that incorporate facility functionality and physical qualities are referred to as BIM. In order to make a strong foundation in selecting the outcome of the building during its life cycle, which is defined as existing from the initial concept to demolition, BIM may also be a source of information about shared facilities. A key component of BIM is the participation of many different stakeholders at various phases of a facility's life cycle to embed, remove, upgrade, or modify data within the BIM to support and reflect the roles of the many stakeholders.

Facilities Management (FM)

The International Facilities Management Association (IFMA) defines FM as a profession that integrates people, place, procedures, and technology to ensure the built environment is functioning. Up to 85% of the building's total life-cycle costs are made up of FM (Chen et al., 2019). In order to make sure that the built environment supports the major goals of the host company, FM is seen as an integrated strategy to running, maintaining, enhancing, and adapting buildings and infrastructure of an organisation (Nutt, 2004). This indicates that FM is a process that concerns not only maintenance, but also several activities in the end of the life-cycle project.

The Integration Between FM and BIM

A line with the vision of The National Building Information Model Standards (NBIMS) for BIM that indicates an improved planning, design, construction, operation, and maintenance process through a standardized machine-readable information model by concerning facility, new or old, which contains all appropriate information created or gathered about that facility in a format useable by all throughout its lifecycle (NIBS, 2008). This vision refers to the integration between parties in BIM adoption of project lifecycle.

In addition, BIM can also be used to solve the building's FM data and information system design's lack of smoothness (BIM Implementation, 2012). Unquestionably, BIM provides a better level of functionality for facilities management (FM) of buildings and other fixed assets to serve as an integrated digital repository for each component of the facility (Jordani, 2010). Unless a person is professionally trained and skilled in deciphering the typical architectural drawings 2D, BIM's full platform of 3D models makes it difficult to understand how these elements are displayed and explained. (Philips and Azhar, 2011).

The Extent of BIM Application in Construction Projects

BIM applications in building projects benefit construction professionals in a variety of ways, including through enhancing a clear communication, understanding and promoting quicker design decisions (Alizadehsalehi et al., 2020). As a result, using BIM can speed up design processes and reduce on the cost and duration of construction (Eastman, C.M. et al., 2011). The use of BIM in a construction project is shown in Table 1 for each phase, which includes the pre-construction, construction, and post-construction phases. As can be seen, BIM has been widely utilised in construction projects to improve multi-layer and types of communication between multiple parties during various project delivery and design phases. (Jardar et al., 2017; David J et al., 2019). This means that the outcome should be produced more effectively since the adoption of BIM has been increased drastically in construction projects.

The Stage of BIM

BIM consist of five stages; this stage is to show the level of development of the technology. This stage called as the Level of Development (LOD). That five stage are LOD100, LOD200, LOD300, LOD400 and LOD500 as shows in Table 2. The consistency of expectations throughout the building's life cycle, including planning, design, construction, and in particular the building's life cycle, is determined by these development levels. Traditional project delivery techniques have been used in LOD 100-300's past. The BIM process only uses 2D and LOD 400 and 500 (Reinhardt & Berdrick, 2013). The purpose of scheduling LOD is to tell all parties concerned about the data or information that can be used to create a project (McPhee, 2013). As a result, the goal of scheduling specifications is to define and explain the LOD structure, making it a more effective communication tool. The LOD level that can be achieved in a project is not specified in this scheduling; instead, it is up to the users of these papers to specify the development model. (Reinhardt & Berdrick, 2013).

Table 1. The BIM Application in A Construction Project for Every Phase (Latiffi et al., 2013)

Phase	Stage	Uses of BIM
Pre-construction	Existing conditions modelling	● Improves the documentation of current situations' correctness.
	Planning	● Identifies scheduling problems with phasing or sequencing.
	Design	● Better communication and quicker design decisions are made possible by doing clash detection and collision analysis. ● Improves the efficiency of the design.
	Scheduling	● Project managers and contractors are able to monitor progress in relation to logistical and time-tested standards by viewing the construction activity sequence, equipment, and materials.
	Estimate	● Enables the immediate creation of measurements, counts, and take-offs from a three-dimensional (3D) project model.
	Site analysis	● Lowers demolition and tilty demand expenses.
Construction	Construction	● Allows for the demonstration of the construction process, including the use of access and exit roads, traffic patterns, and site equipment. ● Better cash flow and expense control tracking is provided. ● Enables real-time task tracking, quicker resource flow, and improved site management.
Post-construction	Facilities Management and Operation	● Tracks built assets and conducts proactive facility management. ● Allows for planned maintenance and offers a history of maintenance evaluation.

Table 2. BIM Stages Level of Development (LOD) (McPhee, 2013)

Level of Development (LOD)	Background
LOD100	Includes the idea of a building, which typically entails the general layout of the building to carry out the full study of various structures, including building orientation and space, cost per square foot during construction, and others.
LOD200	Describes the building design model, including the estimated quantity, size, shape, location, and orientation. The model will include a centralised system. LOD 200 is frequently used to create goals and do system analysis.
LOD300	Making models is a key component of focusing. The model's components in this LOD are analogous to shop drawings and conventional construction documents. Construction cost estimation and coordination for collision detection, scheduling, and visualisation work well with LOD 300 models. Should LOD models contain the characteristics and specifications listed by the owner in the BIM delivery requirements.
LOD400	Include information about model-building production or fabrication. Specialty trade contractors typically use LOD to construct and create project components, including the MEP system.
LOD500	The most recent BIM innovation focuses on building models that are prepared and furnished with facilities management systems. The model building will be set up as a data storage facility to be integrated into the running and upkeep of building systems.

The Challenges of BIM in Facilities Management (FM)

To successfully use BIM, the Malaysian construction industry must overcome a number of obstacles (Ahmad Jamal et al., 2019). The introduction of BIM technology is associated with many challenges and impediments (Gamil & Rahman, 2019). The adoption of BIM is said to consist of numerous basic components, including People, Process, Policy, and

Technology, according to the UK BIM Report 2017. (NBS, 2017). As can be seen in Table 3, there are four basic groups that best describe the BIM issues.

Table 3. BIM Challenge

Factor	Description
Human Factor	For any organization to completely adopt BIM in their projects, their human factor division will have to be go through a complementary change in terms of their abilities alongside a fundamental handle change inside the organization. In expansion, the "human factor" and the resistance to change might hinder effective collaboration between partners. This alludes to the crossing point of established knowledge, encounters and practices of people and associations amid the adoption of a novel concept (in this case BIM), which needs considerable change in established mind-sets and hones (Rostami et al., 2015).
Process Factor	There are now no clear instructions or appropriate guidelines for how to use or adopt BIM. How to use and use BIM in facilities management procedures is not explicitly stated. The transfer of data and information to operational arrangements is currently hampered by the lack of interoperability between BIM breakthroughs and contemporary FM innovations, such as Computer Aided Office Administration Frameworks (CAFM) (Akcamete et al., 2011). The operational operations of a business must change fundamentally for BIM to be fully implemented.
Cost Factor	A company must regularly improve its equipment in order to run the processing computer programme necessary to support BIM in order to apply it efficiently. When it comes to cost, it is obvious that the demand of a significant technological component to apply BIM has become a hurdle for Malaysia's watching over sector. Additionally, as they move forward with implementing a new working environment in their company, the firm needs to take into account the costs associated with training their employees and hiring new specialists who are knowledgeable about and skilled in BIM. According to Eadie et al. (2013) and Hore et al. (2011), BIM adoption may depend on client demand and staff training.
Technology Factor	Majority of the players in facilities management industry see BIM adoption as a "disruptive technology" that give a significant change towards the traditional facilities management process. However, Due to their social communication-based impressions of the new technology and their fear of change, not all of them are using this technology (Suebin and Gerdsri, 2009). This includes transform 3D environment into a complete BIM system with major upgrade of current device and hardware to support necessary software. Besides, BIM specialists have considered Autodesk, Bentley and Nemetschek to be among the technology stages that are interoperable indeed though they don't run that easily together, in spite of there being a few dissents to it. There is less study on using these new technologies in the operation and usage stage of the building life cycle than there is in the design and construction stages (Mario Claudio et al., 2021), particularly for the FM sector.

RESEARCH METHODOLOGY

Research Design

Interviews were chosen as the data collection approach for this study in order to meet the research question and research objective. Semi-structured interviews are the method of choice for interviews. The interview questions are drafted before interviews were held. The researcher was listed out all the potential challenges that faced when adopting this BIM application in literature review. Count on that, the researcher be able to formulate a semi-structured question base on several factor that had been identify.

Research Strategies

While we might already have clear objectives, it is possible that, at this stage, researcher must choose the most appropriate strategy to implement and to address those questions. Diversely, the research result will end up inconstant and it may deliver impact towards the inquire about research objectives. A weak research question will give a view that the research

objectives have not been achieved accordingly. For this reason, researcher pick the case studies as the research strategies for this study.

Research Procedure

Stage 1: Identify Problem Statements and Topic Selection

At this stage, ideas will be presented and discussed with the supervisor. The selection of the title and place of study has been determined. Statements of problems and issues regarding the study are identified at this stage. Identifying issues that arise at an early stage is very important to facilitate the study conducted. The problem of the study is the issue that arises that it becomes the driving force for the researcher to conduct a study on the issue (Hart, 2015).

Stage 2: Literature Research

The second stage is the stage where comments on the topic are made in more depth. The terms used in the title will be explained in more detail so that the study conducted will be easier to understand. The information obtained at this stage is through internet sources from previous journals and from related reference books. Literature review is very important because it helps researchers to understand the study conducted in more depth.

Stage 3: Research Methodology Approach

The third stage is the collection of research data and information. This stage is very important because the collection of data and information can ensure that the study is achieved its objectives and can also be used as evidence. This study uses both type of data for conducting research and determining effective procedures in responding to research problems. Data collecting have been split into primary data and secondary data categories for the study's efficient implementation. Information about BIM use in FM is gathered using both ways. Players in facilities management who have used or are currently using BIM technology or courses were interviewed in a semi-structured manner.

Stage 4: Data Analysis Methods

All the finding in this stage assist researcher to achieve the objectives of the study. Data for this study has been obtained through the case study. The tool for this research was a semi-structured interview. The respondent for this research was limited to facilities management practitioner that have experienced and who are currently involved in BIM technology or courses. As for that, the researcher immediately starts to approach all the respondents through several types of communication medium, such as email, google meet, phone calls, and WhatsApp's. From seven (7) of the facilities management practitioners that has been invited, only three (3) suitably cooperated and being interviewed to gain information about the research. All the data obtained from this interview with the contractor has been record and transcript manually in order to organize the data obtained. This data will be analyse using qualitative content analysis because it can provide a detailed and in-dept description of the content.

Stage 5: Findings

The findings were presented in accordance base on stage 4. Overall, on the basis of the problem statements, the questions and the objectives of the study being formed, then with the proposed methodology outlined in this chapter, both the objectives outlined for this study have been achieved.

RESULTS AND DISCUSSION

Only three (3) participants in this study were willing to comply and were interviewed to learn more about the study by phone and email. The interview session with the respondents takes place from July 2021 until August 2021. The interview session lasted 30 to 45 minutes. Data and information obtained through interviews of respondents were then analysed using content analysis to describe some things related to the objectives of the study.

Respondents' Profile

All four respondents interviewed were in the management position of facilities management company. Three of them was a manager and one of them is assistant manager. All the respondents at least have more than 10 years working experience as showed in Table 4. This is important as to show that the interviewee was suitable for this research. Furthermore, this helps to ensure the data that has been collected are reliable.

Table 4. Respondent's Profile

Respondent	Position	Working Experience
R1	Manager	22 years
R2	Manager	21 years
R3	Assistant Manager	13 years

Objective 1: To Identify the Challenges That Contribute the Adoption of BIM Technology in FM Practice

Based on this interview session, first question and second question show that all the interviewee agreed that the human factor was one of the most important factors that contribute towards challenges to BIM adoption as show in Table 5. As a highlight by certain of the interviewee, mentality on human factor needs more attention as it will give significant impact of challenges towards this adoption. This statement consistent with the findings of Mdletye et al. (2014),that specifically highlight the behaviour of resistance to change indicates that any endeavour to execute organisational change is always met with opposition. Furthermore, according to the interviewee, it is essential to have a skilled worker to operate and monitor this technology. As all aware that this BIM technology is lack of skilled workers in this FM industry. This is consistently mentioned by previous study that building a ready BIM talent is seen as an essential requirement in ensuring the BIM is successfully implemented in Malaysia (Ibrahim et al., 2019).

Table 5. Human Factor Challenges

First Questions Based on your involvement in this industry, did the human factor would give an impact on the adoption of BIM in FM industry? Second Question In your opinion, which of the human factor give the biggest impact on the adoption of BIM in FM industry? Can you please elaborate on it?	
Respondents	**Annotation**
R1	Absolutely, human is the one who gonna use and operate this thing. In this FM approach we involve in technical and technology part which we prefer to have skilled people to suit in it.
R2	Human is the asset of the company so yes it will give some impact. I see most of people refuse to change. But they will do it as the company policy change, but this will slow down the process and not fully adapt or accept.
R3	Of course, it gives impact. Maybe on the mentality of the human itself. Everyone got different opinion on this.

For third question and fourth question, researcher want to know either the process factor contributes the challenge toward the BIM adoption in FM as show in Table 6. All the interviewees believe that the process factor was also one of the most important factors that contribute towards challenges to BIM adoption. However, all of them mention several factors such as the integrations between parties, workplace culture and best-practice guideline for all players.

Table 6. Process Factor Challenges

Third Questions Based on your experience, do you believe that the process factor of the BIM application would give such difficulty on the adoption in FM industry? Fourth Question In your opinion, can you give an example of the process factor that gives the most difficulty toward the adoption of BIM in FM industry? Can you please elaborate on it?	
Respondents	**Annotation**
R1	Yes, if there is no collaboration. As I say, if there is no integration between parties related in that building then you will face some difficulty in accessibility of data for that building for this system.
R2	This is normal. Anything new will take some time to familiar with it. Take COVID-19 as example as new norm of working. This process is necessary. I will stick to my first point, if the human or the workplace reluctant to change form the traditional way to this new method then this adoption process will be difficult.
R3	Yes. This BIM is still new in this industry. Not so many that use plus no proper guide about this. Many interested but no proper path to it.

Fifth question and sixth question help the researcher to assure whether the cost factor influence the challenge faced when adopting BIM in FM As show in Table 7. Two thirds of the interviewee agreed that cost does give challenges in this approach. This is because according to the interviewee, this technology adoption requires a lot of money in term of software related, devices involve and expert BIM worker. This supported by statement made by Kong et al. (2020), cite the fact that, due to the significant initial costs associated with implementing BIM, few businesses are currently willing to make the switch. One of the respondents did point out, however, that if the technology offers greater benefits and long-term technology investment, pricing is not a concern.

Table 7. Cost Factor Challenges

Fifth Questions Based on your understanding, to what extent does the cost factor affect the adoption of BIM in FM industry? Sixth Question In your opinion, between these cost factors which would give the highest effect on the adoption of BIM in FM industry? Can you please elaborate on it?	
Respondents	**Annotation**
R1	No such things. Technology is a must nowadays so never lose investing in this system. For me, if the company or project had decided to adopt BIM there must already allocate some amount of money for it. This is integration or shared of data, of course some cost included but money is not an issue here.
R2	So far, this factor that concern everybody. Many companies scare to adopt it because of the cost involve. It did at the initial adoption, the cost of the related software, devices that need to have and upgraded to support this software and data lastly maybe to hire expert worker specifically in this technology that will also costly.
R3	In term of cost, i will say it give different affect in experience gain from the technology. Financial restrictions. Because not all company have huge budget on this innovation or R&D. Not all effort so subscribes all those software and accessibility in it.

Seventh question and eight question were based on the technology factor itself. This will identify whether this factor would give challenges toward BIM adoption in FM industry as show in Table 8. Overall, all the interviewees agreed that technology factor give some influence that effect on this adoption. Most of the interviewee did mention about the software complexity and accessibility. This statement consistent with the findings of Kong et al. (2020), because it's thought that using a cloud server to share building models and combine models from several disciplines on a single building model is difficult. One of the interviewees brings up the point that handling this sophisticated equipment requires sufficient training to make the situation more exciting.

Table 8. Technology Factor Challenges

Seventh Questions Based on your understanding, how the technology factor would influence the adoption of BIM in FM industry? Eighth Question In your opinion, what is the most influential technology factor that would give significant results toward the adoption of BIM in FM industry? Can you please elaborate on it?	
Respondents	**Annotation**
R1	This factor, it depends on the technology itself. Some of the are very complex to use but we can always consulting with expert and we also have experience and skilled worker. I also notice the constrain in something like license policies in some software that limit it use.
R2	As now with the IR4.0, IOT and others. Technology will influence with one click of button. There must be link of system between parties involved. Open data and big data etc. The accessibility and the exchange of data in important to successfully adopted.
R3	Yes influence, actually we need this technology to make a faster and better decision. But will prefer proper training platform and courses to adopt this technology.

Ninth question assist the researcher to find out whether there were any other factors that concern will give challenges the adoption of BIM in FM industry as show in Table 9. The respondents are concern most on the data and information. One of the interviewees mentions about data lost during the connection or during file exchange. While the other one state that any information and confidential part will leak or expose during the process or collaboration of BIM. This factor will make all FM players become alert of some risk that faced during adoption of this technology.

Table 9. Others Factor Challenges

Ninth Questions In your opinion, based on current BIM adoption in FM industry, what are the others challenges that concern the industry to use this application? Can you please discuss it?	
Respondents	**Annotation**
R1	Internet connection. When we use cloud data all information access will fully be depending on the internet connection. It looks simple but this will completely slow down your work and also create gap in data loss during connecting or during file exchange.
R2	In my opinion, potential that your others company information and confidential part will leak or expose during the process or collaboration. This will include your company internal issue or future plan development.
R3	No comment

Table 10. Summary of Factor That Categorised as Challenge Towards Adoption of BIM in FM Practices

Factor	R1	R2	R3
Human Factor	√	√	√
Process Factor	√	√	√
Cost Factor	X	√	√
Technology Factor	√	√	√
Other Factor	√	√	N/A

Objective 2: To Investigate the Strategies to Improve the Adoption of BIM Technology in FM Field

Lastly, in the tenth question for this interview session. Researcher want to investigate the strategies to improve the adoption of BIM in FM industry. All respondents give positive feedback on this issue as show in Table 11. First respondent recommends convincing client or stakeholder using demo version of BIM that could be testimonial for the company marketing. Next, second respondent suggest creating more project with the involvement of BIM from the beginning to the end process of the project. While the last respondent suggests to develop professional courses to produce more BIM trainers and professional.

Table 11. Strategies to Improve the Adoption of BIM in FM Industry

Tenth Questions In your opinion, what are the best strategies to improve the adoption of BIM in FM industry? Can you please discuss it?	
Respondents	**Annotation**
R1	I will suggest company can make a demo version of BIM to convince the client and stakeholder for using BIM. This also could be testimonial project for BIM adoption in FM. All the success stories will establish awareness and marketing that improve this adoption.
R2	In my opinion, create more project involving BIM. This project has to implement the BIM from the beginning stage until end of the process. So, more information can be gained to produce optimum result or decision.
R3	The related authority must develop a course to produce BIM trainers or professional. Like what is been done by National Institute of Occupational Safety and Health (NOSH) that offer Safety and Health Officer courses.

DISCUSSION

Based on the interviews with the respondents, the finding discovered the result that all the factor listed is contribute to challenge that face during the adoption of BIM technology in FM practice. Additional to that, researcher manage to find out about on one more factor that contribute to challenge that face during the adoption of BIM technology in FM practice. The additional factor identified is:

Risk Factor

This risk factor was highlight based on the response from some of the interviewee on the question towards others factor that give challenges for the adoption. This finding is supported by Mat Ya'Acob et al. (2018), that mention it's important to have a systematic risk management of how risk being mitigates for successful BIM implementation. This risk factors also include the cyber security, intellectual property and data exchange protocol or any potential threats by third party during the process. The interviews conducted were also aimed at obtaining the respondents' views on the strategies to improve the adoption of BIM technology in FM field. Overall, objectives have been successfully met and the results of this study are detailed as follows.

Offer BIM Testimonial

Nowadays, all industry is all about advancement of technology and data. The industry cannot withstand difficulties in both good and bad times without improved capabilities and capacity. (Ibrahim et al., 2010; Zaini Omar, 2000). Thus, R1 suggest that all FM players and practitioner must step forward in offering all the benefit and cost saving that stakeholder and client will gain in adopting this BIM technology. This could be by giving them a demo version of BIM towards current project that cloud attract and convince them to apply this technology. By having this approach, testimonial project automatically gives awareness and marketing towards the stakeholder and clients about what they will get if apply this technology. This in other hands, increase BIM adoption demand and will lead towards improvement to this technology usage.

Create More Project

Additionally, by developing more projects per R2's advice, BIM acceptance in FM practises can be improved. This project must be BIM-based and use BIM systems from the early stages of project creation through its completion cycle. This will improve BIM adoption towards FM industry when there is a complete data and information regarding the building that will influence client or stakeholder decision to continuous using this system for FM practices. All this complete and comprehensive data and information will lead to better decision making and proper maintenance schedule planning.

Develop Training and Courses

Lastly, to improve the adoption of BIM in FM practices the R3 highlighted that a BIM training and courses must be develop. This could be done by any related organization or related authority in FM industry. This training and courses can produce a skilled workers and

professional officer in BIM field. As the increasing of trained worker in this industry, stakeholder and client will not hesitate to adopt BIM in their building because they have a trained workers that capable to manage and monitor BIM and will be pleased by unlimited supply of FM-BIM practitioner.

CONCLUSION

In conclusion, there were several factors that would contribute challenge toward BIM adoption in FM practices. To successfully integrate BIM, the Malaysian construction industry must overcome various obstacles. BIM technology adoption is fraught with difficulties and obstructions. The implementation of BIM consists of numerous basic elements, including People, Process, Policy, and Technology, according to the UK BIM Report, 2017. Thus, the BIM challenges were summarised under 4 main categories. Among the factors was basically human factor, process factor, cost factor and technology factor. However, human factor gives the most contribution of challenge in BIM adoption. This prospect considered because when adopting new technology human as the end users of BIM technology will affect the most throughout their daily basis and working culture. Keep in mind that, everyone embraces change at his or her own pace either by experience gain or training learned. This factor led to work productivity and data optimization because data alone doesn't yield valuable information it must be interpret by human. On the other hand, the study has discovered the result that all the factor listed is contribute to challenge that face during the adoption of BIM technology in FM practice. Adopting BIM means establishing collaboration between all these factors. If these four factors are properly taken into account while adopting BIM, it establishes the impetus for a strong foundation of knowledge and preparation for all FM practitioners. Additional to that, researcher manage to find out about on one more factor that contribute to challenge that face during the adoption of BIM technology in FM practice in the others factor include by researcher. The additional factor identified as The Risk Factor. As technology continuous to triggering, the emerging technologies offer a lot of benefit and also come together with a huge risk in it. Organizations must embrace risk to stay relevant in this unpredictable era. Based on the respondents' responses to the question about other risk factors that present challenges for adoption, this risk factor was highlighted. This conclusion is reinforced by Mat Ya'Acob et al. (2018), who note that for a successful BIM deployment, it is crucial to have a systematic risk management of how risk is mitigated. This risk factors also include the cyber security, intellectual property and data exchange protocol or any potential threats by third party during the process. Finally, this study has been effective in highlighting the challenge of BIM in FM practices adoption and proposed some new factor that can help in the development of the overall adoption of BIM and it is practices improvement.

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